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THE

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ELECTRICAL DEVELOPMENT.

WE notice in the columns of an American contemporary * an admirable little homily addressed by Mr. W. D. Weaver to those terribly optimistic people who, unsatisfied with all that modern electrical science has done for them, are ever anticipating new discoveries of transcendental magnitude, and accept with all the credulity of profound ignorance those scientific fairy tales with which the non-technical press is ever ready to supply them. This attitude arises in part, as Mr. Weaver points out, from the air of mystery with which in the popular mind all things electrical are specially enshrouded. The achieved results of electrical science have struck the popular imagination, and ignorant of the bounds set by the nature of electrical energy, it runs riot in the region of the impossible. To-day the public hears with respectful admiration that one of the Grand Lamas of the electrical cult is ready, nay, it is whispered, anxious, to annihilate whole battalions *en bloc* with the aid of an electrified squirt; to-morrow, that the electric fluid has at last been tracked down and bottled, and can be supplied in various colours, and at the most reasonable prices, for the cure of diseases of diverse kinds. The public finds no difficulty about the reception of these stupendous yarns, and like the young gentleman in fiction, asks for more! Of the unknown and the mysterious, it argues, all things may reasonably be expected.

As a matter of fact, however, the theory of electricity is as firmly established now as are the theories of light and heat, and far more so than that of gravitation, the most familiar of all the forces of nature, and at the same time the most incomprehensible. The time is yet to come when anything even approaching a satisfactory explanation can be given of the fact that a stone released from the hand falls to the ground. We are not, however, always anticipating revolutionary discoveries in thermo-dynamics, optics, or mechanics; we have a distinct and practical idea of the limits of probable development in those sciences, of the boundary between the possible and the impossible.

Moreover, there are limits which we can discern even in the absence of a perfect knowledge of the ultimate nature of electricity. We make our dynamos and transformers now with an efficiency of about 95 per cent., leaving small room for improvement when theory goes still deeper into the nature of the medium we work with. The uncertainty we may feel on such subjects as the dissociation of electrolytes and the migration of ions is not incompatible with a practical working knowledge of electro-chemical equivalents, the corresponding thermo-chemical equations, and armed with this knowledge we are able to turn a deaf ear to the wiles of the primary battery promoter in the certainty, much to be regretted, that apart from the solution of the great problem of the direct conversion of the energy of carbon into electrical

* *American Electrician*, reprinted from the *Annual Journal* of the Brotherhood of Electrical Workers.

energy, no revolutionary change in the cost of production of the latter can be expected. The solution of this problem means an extension of the life of our coalfields of many centuries, revolutionary changes in scores of established industries, the disappearance of such evil-smelling anachronisms and architectural monstrosities as gas works, and incidentally, the enriching of its discoverer beyond the dreams of avarice; but it may well be that our coalfields will be exhausted, and, perhaps, our spendthrift race with them, before the realisation of that great idea.

Mr. Weaver discusses two other attractive problems to which it has been thought that electricity might furnish a solution—the production of light without heat, and the transmission of energy across space without the use of a conducting wire. Much was hoped from Tesla's work on the former subject, but little practical result has been achieved. There is no prospect of the direct production of currents having a frequency of even 4×10^{14} periods per second, the radiation from which would be just visible to the eye as dull red light. The smallest wave length reached even in the oscillatory discharge of microscopic condensers is measured in centimetres instead of in their hundred-thousandth part, and it is only by molecular impact, as in a vacuum tube, that vibrations of a sufficiently rapid order, unaccompanied by heat, have been obtained.

The problem of the transmission of energy across space has recently been brought vividly before the mind in connection with the Marconi system of telegraphy. There is something singularly fascinating in the idea of the Morse key ticking away its message in the room at Bournemouth,* and the printing instrument over at the Needles recording the words just as certainly as though a cable linked the instruments together. But it is a far cry from this achievement to the transmission of energy for power purposes across space. Even the small amount of energy required for the printing instrument is not transmitted, only the infinitesimal quantity required to operate the coherer, which serves as an almost incredibly sensitive relay. The energy from the transmitter is scattered in all directions through space, and the waves can only be gathered into a parallel beam with difficulty and with considerable loss. As yet, moreover, we have no means of generating this particular form of wave energy in sufficient amount to serve any practical purpose, quite apart from the difficulty of transmitting it when obtained. It seems likely, therefore, that we shall have to put up with copper mains, and the $C^2 R$ losses contingent thereon, for some time to come, in spite of the advantages that wave motion in the ether seems to offer as a practically wasteless mode of transmission.

The American Iron Trade Prospects.

The *Scientific American* states that from four of the Lake Superior iron mines, viz., the Marquette opened in 1856, Menominee opened in 1880, Gogebic opened in 1884, and the Mesabi opened in 1892, there have been produced over 98 million tons of ore. The last mine alone produced in five years over 8 millions of tons, one half of which ore is of over 60 per cent. iron, and contains only 0·06 per cent. of phosphorous. In this mine there is in sight or indicated some 400 million tons, or sufficient at present production for 50 years. As all the above mines must continue at present rates if the present rate of iron manufacture is to be maintained, there will need to be a vast further body of ore if America is to keep the lead for an indefinite period. There appears good reason to endorse Mr. Jeans's prediction that the centre of iron production may yet shift to other countries, as, for example, Australia. But for many years to come the continent of North America is likely to increase its output of iron. It is still considerably behind the production of the equal area of the European Continent; indeed, has only just exceeded the production of England, a small section of Europe, about half the size of a moderate American State. The advantages of the Lake Superior ores generally are their great accessibility, being often surface mined and well placed for cheap working; they are very rich in iron and low in phosphorous, and so are eminently Bessemer ores, and the ore beds are of great extent. Some samples assay over 67 per cent. iron, and out of nine grades of ore in the Vermilion ranges none went less than 60 per cent. Phosphorous is very rarely over 0·1 per cent. On the Mesabi range a steam shovel can load 500 tons per hour at 7½d. per ton on the cars, and at times it is claimed cars have been loaded for 5d. per ton. Evidently there will be no scarcity of iron in the lifetime of anyone living to-day.

* Electrical Review, Vol. xlii., p. 538.

Economy of Hot Feed.

Mr. MacFarlane Gray has again drawn attention to what Mr. Kirkaldy first discovered, that it pays to heat feed water with live steam drawn from the same boiler into which the feed is being put. Mr. Gray only attempts to explain it by increased mobility of water. Our contemporary, the *Electrician*, attempts a more scientific explanation, that the economy due to this live steam feed heating is due to the better thermo-dynamic efficiency of heat transmission from fire to hot water than from fire to cold water. The larger temperature drop in the case of cold water is useless. Heat ought to be transferred as near the maximum temperature as possible. If this feed-heating question can be explained thermo-dynamically, what a chance the men have missed who, like Mr. Gray, are thermo-dynamicians and yet have failed to fit the practice to theory. Are we again to see a thermo-dynamic theory fitted to a proved practical fact, for there seems now no reason to doubt the facts. It is an unfortunate shortcoming of most scientific men that they are not possessed of the ability to foresee facts from their theoretic knowledge, though they are very ready to assert themselves in picking the flesh off the skeleton and exposing the hard dry bones beneath. Practical men would be glad of a few X rays of scientific research to show the bones in the living creature without the process of stripping off the flesh. It has been held that the only duty of the furnace ought to be to supply the latent heat to the water in a boiler. To a very large extent this has been followed in north country practice where heat of low degree, otherwise going to waste, is employed to heat the feed in the economiser or flue feed heater, and this may account to some extent for the good evaporative results obtained there from plain boilers.

Institution of Electrical Engineers.—Last night at the ordinary (extra) general meeting, held at the Society of Arts, a paper was read on "The Prevention of Interruptions to Electricity Supply," by Mr. Leonard Andrews, Associate.

CARBON BRUSH-HOLDERS.

By ERNEST KILBURN SCOTT.

Part I.

(*Concluded from page* 564.)

The other more widely known but, perhaps, little understood method, is by the use of a solid carbon block, or, better still, by a multi-section carbon brush. Fig. 4 shows such a

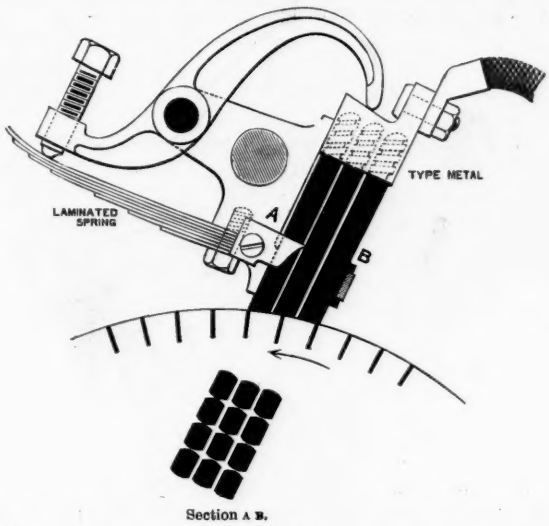


Fig. 4.

brush and holder designed by the writer, from which it will be seen that the brush is made up of the scrap ends of ordinary arc lamp carbons bunched together, as shown in the section A B. Type metal is cast round them at one end, and in order to get the metal to hold properly they are spaced about $\frac{1}{16}$th inch apart, thus giving the multi-section brush. When the carbons are worn away the type metal can be melted off and used over again. In connection with this holder it should be noted that the tangential pressure keeping the brush firmly against the holder casting, can only be fully utilised when the armature is revolving in the direction of the arrow.

The immediate effect of increasing the resistance in the circuit of the short-circuited coils may be explained as follows: When working at full load the coil under short circuit must be in a field of considerable strength, in order that the current may be properly reversed. It follows, therefore, that if the load is allowed to fall off without the lead being proportionately reduced, the field will naturally tend to cause an excessive flow of current through the short-circuited coils. This is where the above-mentioned extra resistance comes in, as a check against the rush of current and consequent arcing and waste of heat.

Another point in connection with the design of brushes and commutator is, that the interval of short circuit, or, in other words, the width of a brush, has a marked effect upon sparking. On a given dynamo, with single-wound armatures, for example, commutation can be more easily effected in a strong field if the brushes cover several segments instead of only one. One may therefore argue that a high induction density in the armature is not only a good feature because it reduces the weight of copper and iron per kilowatt output, but that it also allows of a thick brush being used, or, in other words, it shortens up the commutator. Where currents running into thousands of amperes have to be dealt with, the advantage of this is obvious, for even with double or quadruple wound armatures the cost of the commutator is a heavy item in large output machines.

When a commutator appears to work well at first, but afterwards becomes badly scored, it will generally be found that it is caused by the proportions being such that the contact surface between the metal brush and the receding segment of the commutator decreases more rapidly than the current which is flowing; the result of this being that too big an amperage is crowded into the surface of the brush, causing it to fuse and stick. It is this fusing of the metal (shown when it is very pronounced by yellowish sparks) that scores the commutator, the small bluish sparks which spit off from the outer edge of the brush being comparatively harmless. Carbon brushes being infusible prevent this trouble.

Part II.

As the designs of brush-holders are very numerous, it will be necessary to confine the purely descriptive part of this article to a few typical types. Most brush-holders intended for metal brushes have the one great fault of not allowing the brush to be automatically set up by a parallel feed. On many holders, for example, it will be noticed that as

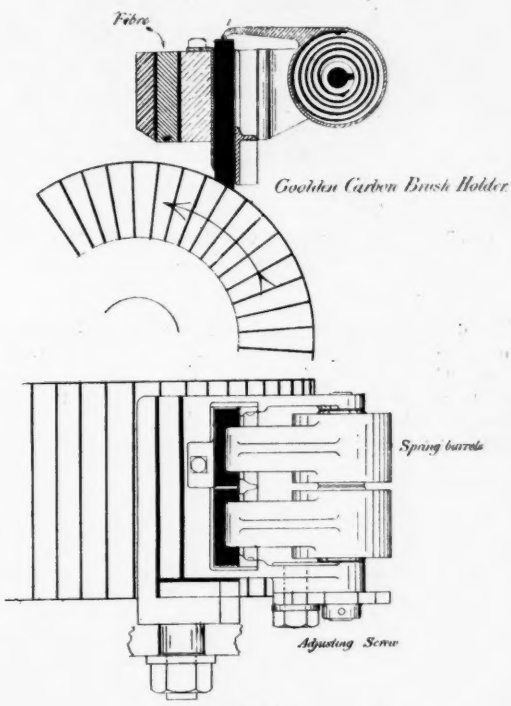


Fig. 5.

the brushes are worn down, the wearing end gradually drops away from its proper position, until (if left without adjustment for a long enough period) it becomes almost square across, and causes sparking by reducing the lead.

Designers of carbon brush-holders appear to have borne this in mind, with the result that in most types the brush remains in the same position relatively to the commutator.

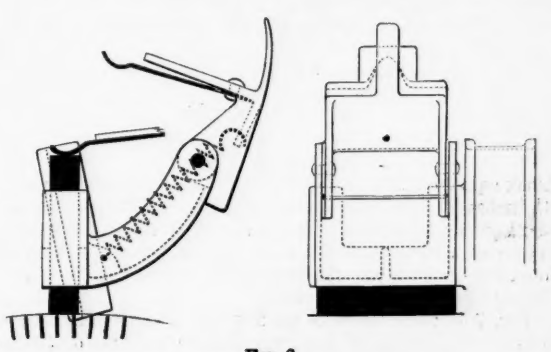


Fig. 6.

It has also, no doubt, been partly due to the fact that carbon wears perfectly with a square end; in fact, reversing motors must of necessity have the carbon in the radial position.

Fig. 5 shows a type of brush-holder which was designed for the earlier Goolden motors for use in colliery work, hauling, coal cutting, &c. It was one of the first to take advantage of the tangential action of the commutator to prevent chattering, a point of considerable importance not only on account of the noise and sparking at the commutator, but also because it is liable to set up sparking between the carbon and its holder.

The barrel with its concentrically coiled spring, shown in sectional elevation in the figure, makes a very neat arrangement, but in the event of the spring breaking or loosing its temper, it is a trifle awkward to replace. The carbon blocks were $2\frac{1}{2}$ inches long × $1\frac{1}{4}$ inches × $\frac{3}{8}$ inch thick, and were covered with a layer of electro-deposited copper.

Fig. 7.—Brush-Holder of the Steel Motor Company, Johnstown, U.S.A.

Fig. 6 shows a side and end view of the brush-holder of a Thomson-Houston tramcar motor as made by the General Electric Company of America. The finger or hammer lever is shown in the raised position with the spiral spring just below the centre of the pivot. The end of the finger is also shown dotted resting on the top of the carbon block as it would be in actual work. When new, the carbon is $3\frac{1}{2}$ inches long and has a bearing surface on the commutator of $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch. The slot in the brush-holder casting is deep enough to allow the carbon wearing down to $1\frac{1}{2}$ inches long, the pressure due to the spring being about the same during the whole of the travel.

Fig. 7 is taken from a photograph of a pair of carbon brush-holders made by the Steel Motor Company, of Johnstown, U.S.A. The carbons are removed, and the right-hand holder is shown with the hammer lever caught back ready for a carbon to be put into position. The brush-holder yoke is fastened to the top half of the motor frame, and it can be removed along with the brush-holders without disturbing the adjustment, this removal being affected through a malleable iron cover on the top casting of the motor.

The Walker Manufacturing Company, of America, makes the type of holder shown in fig. 8, which allows the carbon block to adjust itself to a bearing, whilst at the same time advantage is taken of the rotation of the commutator to keep the carbon firmly pressed against the metal part of the holder. The current does not therefore have to pass through bearing surfaces or springs, and the type is on this account very suitable for large currents. The facility with which the old carbons can be removed and a new set put in, is a very noticeable feature, and it will also be noticed that chattering is entirely prevented.

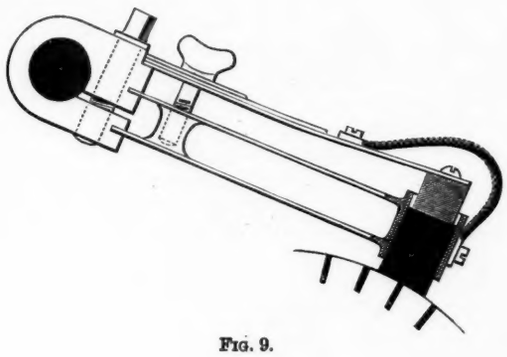


Fig. 9.

Spiral or coiled springs are always more or less a nuisance, and attempts have therefore been made from time to time to use flat laminated springs for the purpose. Fig. 9 shows a brush-holder with a spring of this type similar to those used on the motor-generators at the Electric Cab Company's charging station, Lambeth. The design is somewhat crude, but judging by the appearance of the commutator it seems to answer its purpose very well.

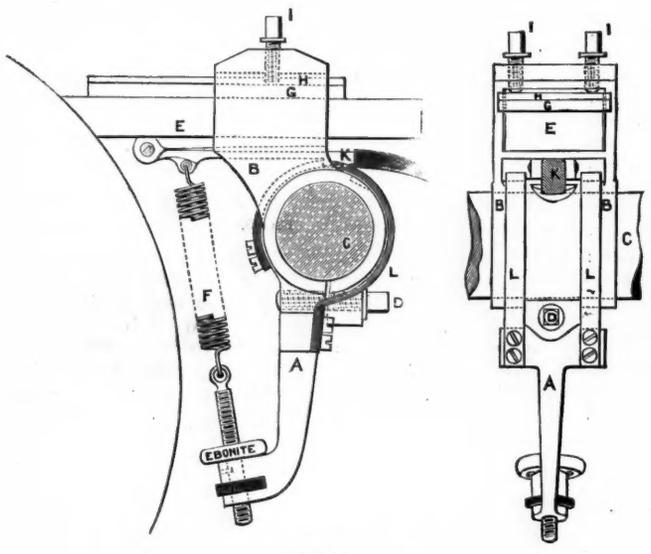


Fig. 10.

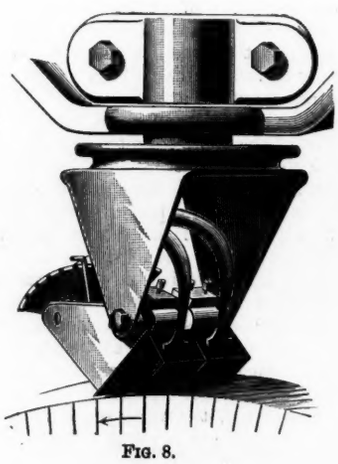


Fig. 8.

Fig. 10 shows a well designed brush-holder made by Siemens Bros. & Co., of Charlton, and fitted by them to the large dynamos for the new Waterloo and City Railway. The carbon block is 7 inches long, 2 inches wide, and 1 inch thick, and in order to make it bed more easily it is held in place by an ordinary copper gauze brush as shown in the figure. The action of the holder is as follows:—Casting B moves round the fixed spindle, C, whilst the casting, A, may be firmly clamped to C in any required position by the screw, D. The main part of the current is conveyed from the brush

casting, B, to the spindle, through the flexible copper strips, L, and the carbon block, E, can be lifted and held off the commutator by means of the spring catch, K, which is fitted with an insulated end. The brush is drawn back into position when this catch is released by means of the spring, F, which also allows the pressure of the carbon on the commutator to be regulated.

Fig. 11 shows a carbon brush-holder suitable for a small machine. As will be seen it is very simple in construction, and, of course, it could only be used for small currents.

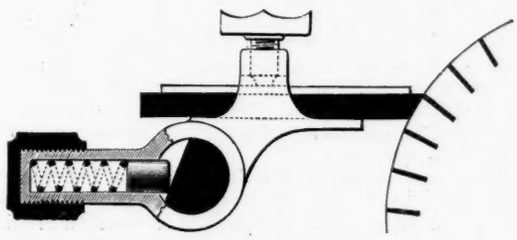


FIG. 11.

The following tabulated particulars of brush gear, &c., may be found useful to designers and others:—Assuming the amperes per square inch of contact for carbon brushes at about a quarter of that allowed for metal gauze brushes, and taking the usual standard sizes of machines and for brushes, the following particulars will hold good.

Amperes.	Metal gauze brushes.		Carbon brushes.	
	Number.	Size.	Number.	Size.
20	1	7 × 2 × ¼	1	3½ × 2 × ½
45	2	7 × 2 × ¼	2	3½ × 2 × ½
75	2	7 × 2 × ¼	3	3½ × 2 × ½
115	3	7 × 2 × ¼	3	3½ × 2 × ½
165	3	7 × 2 × ¼	4	5 × 2 × ½
225	4	7 × 2 × ¼	4	5 × 2 × ¾
300	4	7 × 2 × ¼	5	5 × 2 × ¾
450	5	7 × 2 × ¼	5	7 × 2 × 1
600	6	7 × 2 × ¼	6	7 × 2 × 1

The sizes of brush flexibles may be taken as given in the following table, which is based on a current density of about 2,000 amperes per square inch.

Diameter of copper in inches.	Area in square inches.	Maximum safe current in amperes.
1/8	·019	20
3/16	·021	45
¼	·037	75
5/16	·058	115
3/8	·083	165
7/16	·112	225
½	·150	300
Two 7/16	·224	450
Two ½	·3	600
Three ½	·45	900
Four ½	·6	1,200
Five ½	·75	1,500

The widths of commutators vary a good deal, but they are all based more or less of the standard 7 inches × 2 inches × ¼ inch brush, as follows:—

Number of brushes side by side.	Width of commutator in inches.	Diameter of rocker spindle.
Two 1" or one 2"	2⅜	⅜"
Three 1½" or two 2"	5¼	½"
Four 1½" or three 2"	7⅛	⅝"
Four 2"	9¾	⅝"
Five 2"	12	1"
Six 2"	14¼	1"
Seven 2"	16⅝	1¼"
Eight 2"	18¼	1¼"

THE UTILISATION OF BLAST FURNACE GASES FOR ELECTRICAL POWER TRANSMISSION.

By W. H. BOOTH.

(*Concluded from page* 532.)

FROM a careful consideration of results obtained, it would appear that the amount of power that may regularly and continuously be obtained from a blast furnace is 10 horse-power per ton of coal per week. Thus a furnace burning 1,000 tons per week would yield 10,000 horse-power continuously under correct conditions of work, including the driving of the blast by gas power and sundry other economies into which it is not necessary more fully to enter. The foregoing figures will probably be sufficient to show that there is a calculable saving of enormous extent to be made. My tests of the actual plant more than confirm the figures, and it is beyond cavil that the system is a success, commercially as well as mechanically. Several other plants of utilisation are either at work or projected, including one at the Frodingham Ironworks, one at Barrow, and an entirely new plant, including a new furnace in France; but of more than special interest is one to be put up at the Wigan Iron Company's works in Lancashire, the special interest attaching to this being that a length of 1½ miles of canal has been selected on which to make a trial of electrical traction as

TABLE I.

	Blast furnace gas.		A gas producer.
	Wishaw.	Frodingham.	
Carbonic acid	5·75	6·0	6·6
Carbonic oxide	24·75	27·3	19·6
Hydrogen	2·33	1·5	6·4
Marsh gas	0·75	...	1·3
Nitrogen	66·42	65·2	66·1
	100·0	100·0	100·0
Heat units per cubic foot ...	97·8	96·7	98·0
Calculated cubic feet per I.H.P.	79·44	80·34	79·27
Percentage combustible ...	27·83	28·8	27·3

applied to canal barges. In this installation a gas engine of about 30 H.P. will be employed, generating electricity for three separate purposes. One of these is the lighting of the ironworks as is being done at Wishaw; the second is the purification of the blast furnace gas itself by electrification, the gas passing through a highly charged field, and depositing its load of dust which aggregates and coalesces and drops by gravity out of the gas stream. The third use of the current is, as stated, for canal barge traction by means of small motors running upon a lattice-framed rail carried on posts along the towing path. There is, perhaps, nothing in the mere transmission of electricity along a short length of canal, but the matter has nevertheless considerable interest as being the first use of electric current generated by furnace gases for power purposes outside the premises on which the waste gas is manufactured. Electrical transmission of power is common, and the problem of the wasteful blast furnace only waits the application of this solution to be at once recognised as a source of power of almost unlimited extent.

If about 10 million tons of fuel are used annually in English and Scotch blast furnaces, then about 2 million horse-power is running to waste. Unlike huge water powers, or even small ones, the utilisation of blast furnace gas does not involve a great capital expenditure on works of preparation such as dams, tunnels, pipe lines, aqueducts, &c., as required where a water power is sought to be developed. Seeing that this 2 million horse-power is located at about a score of centres all over the land, there is an average of

about a hundred thousand horse-power to distribute from each. Electrical transmission alone is possible in this matter. It would be sheer waste of time to consider any other system of transmission than that afforded by electricity. The only cost is that of gas engines and cheap light holders, scrubbers, and pipes. To what use can all this current be applied ?

The whole of the cotton mills in the country would not, if properly driven, absorb a fourth of the supply. The most obvious use, apart from factories, is that of transportation and light. Between them none of the gas produced in the country need go to waste. Electrical traction may be looked on as the next coming industry, the application to which of the new power involves no rejection of old plant, no change in existing conditions, and no subversion of established ideas. The obvious power for most new tramways is electricity, and it is bound also to be applied to most old lines, if these are to live in competition with new ones.

The application of electricity to main line service may well wait until the tramway system of the country has been modernised and extended. No engineer who had the means at his command need hesitate to undertake the supply of ample power to the London underground railway from the iron furnaces of Northamptonshire. Some of the furnaces are at rest. With a very moderate payment for the gas now sent to waste, the profitable joint production of iron and gas would keep these furnaces alight. To Wellingboro' is only 63 miles from London, and the Wellingboro' furnaces are probably the nearest to London. A transmission of 60 miles is nothing to be afraid of. Greater distances are now finished or in hand in America on water-power transmissions. Hence it is perfectly possible and practicable to transmit power to London from Wellingboro' for railroad purposes, adding at one stroke to the prosperity of the decaying iron industry, and rendering the sulphurous underground tolerable. The question of electric traction seems to turn so much on the constant expense of fuel that where this can be had for a fraction of its normal cost there would be great inducement to undertake the building of the transmission line.

It must not be overlooked that the production of blast furnace gas is continuous ; furnaces do not stop, but work on for years under blast. The volume of gas produced is enormous, and from one furnace may be a million feet per hour. It is thus essential that, in order to avoid blowing gas to waste, there must either be an immense storage system or the use of the gas must be as uniform and continuous as it is possible to make it. For power purposes of manufacturing establishments there is a fairly constant load over 12 hours of the day, and there is the night load for lighting purposes, but there is rarely much of a load for any purpose beyond street lighting between 12 p.m. and 6 a.m. Assuming that a given furnace is capable of yielding a continuous 6,000 H.P., the possession of sufficient storage capacity to absorb the production of the six night hours would increase the power capacity during the 18 hours to 8,000 H.P., and similarly very much more than 8,000 H.P. would be possible at the hours of maximum demand, such as from 9 a.m. to noon, or the evening overlap of large power and light demand which occurs between 4 and 6 p.m. in winter, where a system of storage is adopted. The storage resolves itself into a question of demand. As soon as the maximum rate of demand exceeds the rate of supply, the addition of a holder will tide over the peak of the demand "curve." Further growth in demand can be met by further storage. The question of storage will not be of immediate urgency. So much power is going to waste that it will be a long time before unbelief is overcome sufficiently to absorb all the power available. In no industry, however, has the production of a large and apparently useless waste been allowed to proceed indefinitely. In the production of the ordinary illuminating gas, the bye-products, once so difficult to dispose of, have become almost the primary profits, and gas has become, in a sense, the bye-product. In the Scotch blast furnaces using raw coal the tar and ammonia recovery has added a very welcome margin to the profits of pig-iron production ; and so in many other industries. Yet in none is there so huge a waste as that represented by the gases, still practically thrown away, of the blast furnace, and only capable of employment to their full capacity by the combined agency of the internal combustion engine and the dynamo, with its attendant long-distance transmission.

The recent articles of Mr. J. S. Jeans dealing with the subject of supremacy in iron manufacture have a very close and special relation to this question of waste utilisation.

Table II.

Gas.	Per cent. Volumes.	Weight per cubic foot.	Weight per 100 cubic feet of mixed gas.	Ratio of constituents.	Actual weights of elements per 100 cubic feet of gas.			
					C.	O.	H.	N.
Carbonic oxide = CO	24·75	0·0784	1·9404	3 : 4	0·8316	1·1088	...	...
Hydrogen = H	2·33	0·0056	0·0130	...	...	...	0·0130	...
Marsh gas = CH_4	0·75	0·0448	0·0336	3 : 1	0·0252	...	0·0084	...
Nitrogen = N	66·42	0·0784	5·2073	...	...	...	...	5·2073
Carbonic acid = CO_2	5·75	0·1234	0·7095	3 : 8	0·1935	0·5160	...	...
Cubic feet =	100·00	0·079038	7·9038	Total	1·0503	1·6248	0·0214	5·2073
					7·9038			

By its means the production of iron in a small country of short distances is placed in a better competitive position than is the case with the furnaces of a large country more sparsely populated and less able to absorb the power production of a furnace within a reasonable radius. This consideration is of great importance to the British iron trade, and, indeed, to the country at large, which is placed in the same advantageous position that is now occupied by countries of large water powers—Switzerland, Scandinavia, or America. Given also increased powers of electrical transmission, and the injustice to Ireland which she has suffered in the denudation of her carboniferous strata may be considerably ameliorated in the not far distant future. These are, however, mere speculations; the solid fact remains that a new power source, of at present unlimited extent, is ready to our hands, and comparatively small expense is needed to utilise it for every purpose of light, power, and even of warmth.

It has been argued that the waste gas might be utilised for similar power purposes by burning them under steam boilers, as now done for the purpose of raising steam for the blowing engines. This argument overlooks the fact that the heating power of all these producer gases and their congeners is very poor. One pound of carbon produces about 7 lbs. of gases, and the minimum air supply is another 6 lbs., so that at the very least a pound of carbon results in the production of 13 lbs. of products of combustion. The carbon has only a calorific value of, say, 10,000 units, one-thirteenth of which, or 770 units, is apportioned to each pound of the products which have a specific heat of about 0·23, so that the maximum possible temperature attainable beyond the initial is only 3,350°, and this is liable, indeed certain, to be very much reduced by the excess of air always present. The flame of carbonic oxide is not a suitable flame for boiler heating purposes, being too transparent, and therefore devoid of radiating capacity. On the other hand these poor gases are very suitable for gas power purposes, and lend themselves readily to the peculiarities of the gas engine, especially in respect of that still unavoidable water-jacket. Rich gases

must be diluted, and the poor gas is already dilute and only requires that a slight variation be made in the ordinary proportions of the air and gas inlets and in the piston base for purposes of greater compression. There is no difficulty in igniting these poor gases, in the cylinder of a gas engine, under compression. Gases almost too dilute to burn in the open will readily ignite when compressed.

THE EFFECTS OF ALTERNATING CURRENTS ON THE HUMAN BODY.

By Dr. W. S. HEDLEY.

There have lately been recorded (*Electrotechnische Zeitschrift*) a series of experiments undertaken by Prof. Weber, of Zurich, to determine the effects upon the living body of alternating currents at different voltages. Two metallic conductors at opposite potentials were held, one in each hand. With the hands damp, an effective electromotive force of 30 volts, and 50 alternations a second, the whole arm seemed paralysed; extended, it could not be flexed; flexed, it could not be extended. At the same time, the pain was so severe, that it could not be borne for more than five or six seconds. It was not without effort that the hands could be detached from the electrodes. When the voltage was raised to 50, fixation occurred; that is to say, the hands could not by any voluntary effort be released from the electrodes, and the pain was not supportable for more than two or three seconds. With the voltage raised to 80, even with the hands dry, all the above phenomena were accentuated.

Other experiments followed to observe the effect of a current passing to earth through the body; thus, standing on a damp macadamised road, but with dry shoes, a person touching with his hand a conductor at a potential of 1,000 volts experienced a marked burning sensation, and when the conductor was grasped with the whole hand a violent tremor occurred, with complete fixation.

In the same journal M. Emile Kolben gives a case of an accidental contact of several minutes' duration, where the body was placed in the path of a current passing from hand to hand at 200 volts. In our present ignorance of the exact conditions which make electric currents dangerous, experiments of this kind are of great interest and value, and it is desirable that all such cases be assiduously recorded. But it is altogether premature to conclude, because the voltage of electric lighting currents may but little exceed that used in some of these experiments, that therefore such lighting currents are free from danger, or that a person with dry shoes, standing to earth on moist ground, need never be afraid of an alternating current whose potential does not exceed 1,000 volts. In a recent number of the Electrical Review, reference is made to four fatal cases of accidental contact with live wires, in three of which the potential could not have exceeded 115 volts. Data must for a long time be accumulated, and a great deal more learnt about the human body as an electrical conductor before the line can be drawn beyond which electrical currents begin to be dangerous to life.

BALANCING OF ENGINES.

The recent paper by Mr. Whitcher, read before the Manchester Association of Engineers, deals with engine balancing on the lines, lately come into fashion, of the bob-weight, a method so obviously correct in theory as to need no demonstration, and, indeed, a method which has been often attempted approximately. As the author points out, the balancing of an engine is an endeavour to hold fast its centre of gravity. Slow moving engines having small energy of motion in any part are sufficiently balanced if they will remain at rest in any position in which they are placed. Such are the old beam engines which can be balanced by a weight in a fly-wheel. In such engines we can neglect the twisting moments about a vertical axis, due to revolution of balanced parts, and their balances in different planes. More quickly moving engines can be balanced by tail cranks and fly-wheel weights, the weight being in the same angle as the crank and the tail opposite, a method very efficient for long stroke engines up to 900 feet piston speed. But these methods do not really balance the piston and other parts which move in right lines; they introduce a vertical disturbing force in horizontal engines, or a lateral force in vertical engines, which have to be dealt with by the absorbing power of more or less heavy foundations.

The conviction of most engineers that a steam engine with two cranks must have these cranks at right angles, has prevented a good deal of excellent work being done. With a three-cylinder engine very good balancing can be effected by keeping the middle crank opposite the two outer cranks and of equal weight to the sum of the two.

Mr. Whitcher considers one of the most important effects of balance to be the effect on bearing surfaces, and he shows how alternating stresses on bearings which produce knock may be converted into rotary stresses free from knock. A revolving counterweight does this at the cost of introducing a general vertical want of balance. He describes briefly various methods, and regrets that the three-cylinder engine with cylinders at 120° on one crank is so inconvenient a machine, being perfectly balanced by a single weight opposite the crank. He criticises the six-cylinder Willans idea, considering the four-cylinder idea of Messrs. Schlick, Yarrow and Tweedy to be superior and simpler where the cranks are placed nearly 90° apart, but so far different from 90° as to correct the irregularity due to angularity of rods. He recommends his hearers to attack the problem from this point.

For two-crank engines, nothing, of course, can be better than a crank angle of 180°, with cylinders as near as possible to each other to suppress twisting moments. With three cylinders there is a fair balance possible. Four cylinders are better. For single engines there is the bob-weight system, and the author questions if it be not better always to treat every cylinder alone, and give up the attempt to balance moments by means of multi-cylinder schemes.

One of the author's methods is to lengthen the connecting rod beyond the crank-pin, and put a bob end to it, so as to balance the transverse component introduced by the rotary crank tail. The same effect is shown by a system of linkage which will obviate stresses otherwise brought on the cross-head slides by the previous system.

Mr. Whitcher makes a severe dig at locomotive engineers who of all men, with unbalanced vertical components in a heavy machine, set to run over rails supported at intervals only, and over costly bridges easily damaged by vibration and its cumulative effects, ought to seriously consider balance. He suggests how locomotives ought to be balanced. The present writer would balance locomotives by giving them three or four cylinders with the cranks of the outer cylinders 180° from the inside crank or cranks, and with equal mass moments. But locomotive engineers apparently dare not depart from their antiquated ideas of cranks at 90° so as to be able to start from any position.

They will not accept the little turning engine, so easy to be applied, nor will they try the above system with the cranks slightly off the 180° position, which would generally secure a start, and yet would so greatly reduce the present vertical component so destructive of rail joints, bridge floors, and girders.

Mr. Whitcher's paper is deserving of study and attention, because balancing, though really a simple matter, is by no means always so simple in practice as in theory. Its difficulties arise with frequent reciprocation of parts, and disappear altogether in electric motor work and steam turbines.

ELECTRICAL ALLOYS.

By ROLLO APPLEYARD.

(*Concluded from page* 537.)

II.—New Alloys.

It was thought that some further diminution in temperature coefficients could be obtained, for it was found that with some specimens of patent nickel examined at the

Reichsanstalt this constant had fallen to 0·00017. It appeared that this diminution resulted from increase of nickel in the constitution of the alloy. A number of experiments were therefore made with copper and nickel, or similar metals, in order to investigate the effect of the quantity of nickel upon the temperature coefficients. Alloys of copper and manganese, such as were being made by Dillenburg at the Isabell foundry for parts of machinery, were examined. The Reichsanstalt were encouraged to pursue this investigation by the success of the patent alloys of Weston, of Newark (American patents Nos. 381,304 and 381,305), which were described as having negative temperature coefficients. Twelve nickel-copper alloys, with different quantities

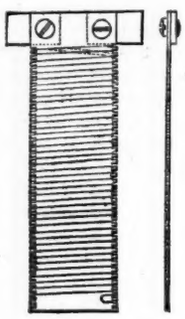


FIG. 1.

Variation of the resistance of alloys of manganese and copper with temperature.

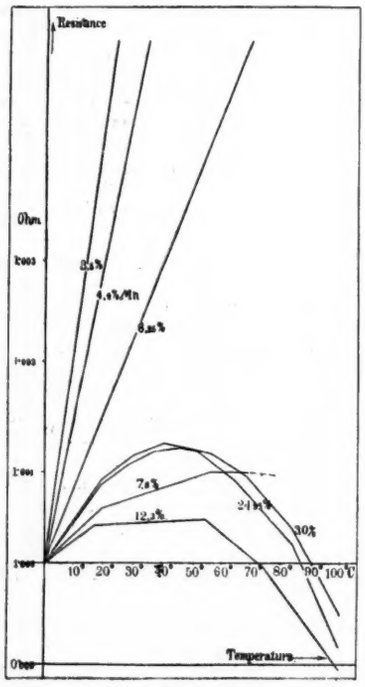


FIG. 4.

Temperature coefficient α, specific resistance ρ and thermo-electric force (against copper) S the constitution of the alloy of nickel and copper.

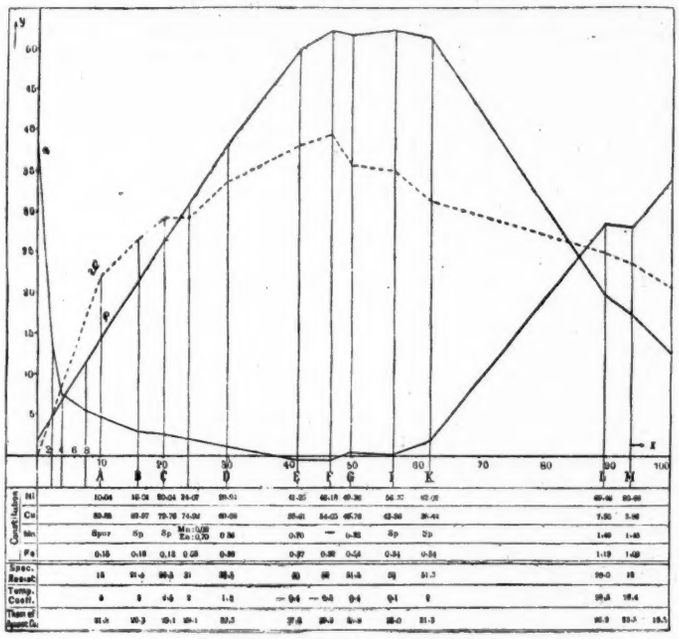


FIG. 2.

Variation of manganin with temperature.

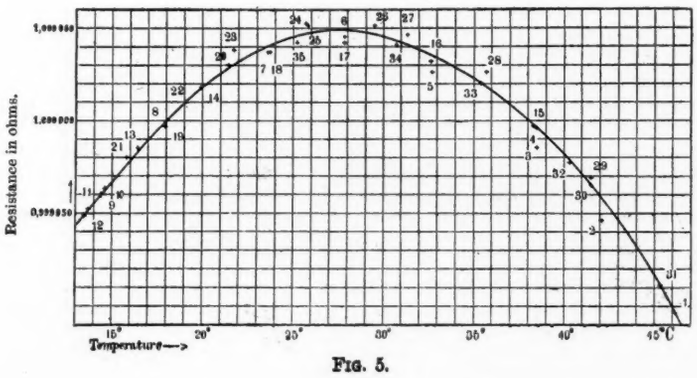


FIG. 5.

of nickel, were therefore specially manufactured for them by Basse and Selve, in Altena, Westphalia. The specific resistances and temperature coefficients were determined from wires of 0·5 mm. diameter and about 2 m. long, soldered to copper contact pieces, and, after their diameter and length had been measured, wound double upon a strip of mica, as represented in fig. 1. Afterwards these wires were kept in a thermostat at 120° C. in a dry heat for 24 hours. The wire was then put into an oil bath, and its resistance was measured at different temperatures. The results corresponding to both groups of alloys are given in curves in figs. 2 and 3. Abscissæ in fig. 2 represent different alloys of nickel, the ordinates marked ρ represent the specific resistance in microohms per cc.; those marked α represent the temperature coefficients, giving the significant figures after four decimal places. The ordinates drawn to meet the curves represent the observed values. Fig. 3 sets forth the same data for manganese alloys. Fig. 4 shows the variation of resistance with temperature for various alloys of manganese and copper. These alloys can only be examined up to 30 per cent. of manganese, as alloys beyond that limit cannot be worked.

Both with copper-manganese and copper-nickel alloys, the specific resistance increases in proportion to the added manganese or nickel; up to this 30 per cent. value, the resistance of copper-manganese increases about 2·5 times as rapidly as copper-nickel. With the latter alloy, the resistance then diminishes up to 46 per cent. of nickel, and then remains fairly constant up to 62 per cent.; after that, it falls steadily until the metal is all nickel.

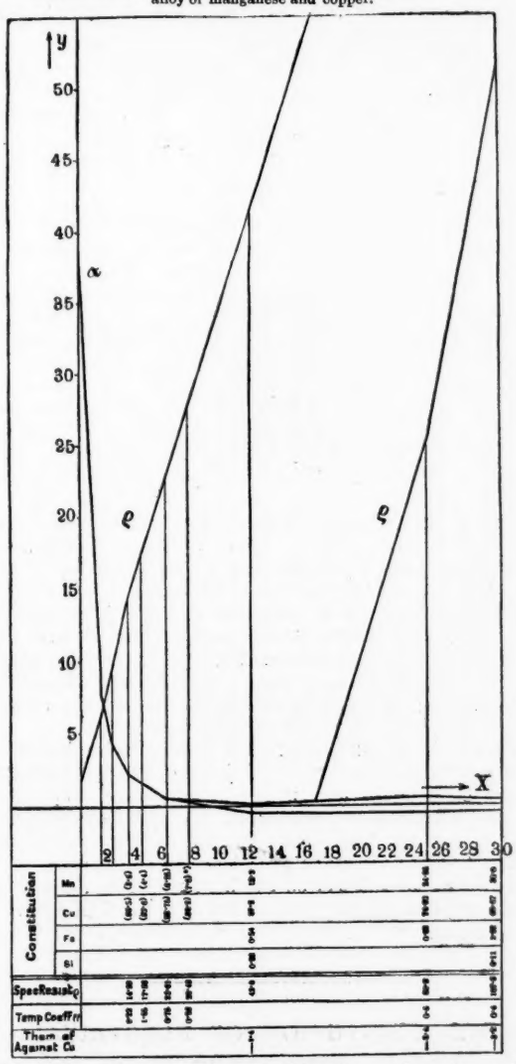
With manganese-copper, the temperature coefficient diminishes at first very rapidly, then gradually slower, until at 7 per cent. of manganese it becomes *nil*. Beyond that point, increasing the quantity of manganese produces an alloy which at 0° C. has a small positive temperature coefficient; this vanishes at from 40° C. to 50° C., and beyond that temperature assumes increasing negative values. In fig. 4 the ordinates of the seven curves show these various results, each represents the change in resistance experienced by a wire of 1 ohm when its temperature is varied from 0° C. to 100° C.

With nickel-copper the diminution of temperature

coefficients as the nickel is added, is slower than the change noticed when manganese is added to manganese-copper; it is slower in the same proportion as the increase of specific resistance is less. Close to the zero-line there is a bend to the curve of alteration of temperature coefficients, the second part of the curve is not horizontal, but has a slight upward inclination, and then falls somewhat rapidly towards the zero line at 46 per cent. of nickel. This alloy gives the least temperature coefficient. At this same 46 per cent. value the specific resistance also attains its maximum.

The alloy represented by F (fig. 2) has approximately the chemical formula Ni Cu. In these alloys it may be supposed that the combination of one molecule of nickel with one of copper is mixed with different quantities of copper and nickel, and that these possess high specific resistances and negative temperature coefficients. The practical result of this investigation is to show that it is possible to obtain two kinds of alloys with vanishing temperature coefficients. With manganese-copper only 7 per cent. of manganese is required to produce an alloy of infinitesimal temperature coefficient. In practice, 12 parts by weight of manganese, 2 of nickel, and

Temperature coefficient α, specific resistance ρ the constitution of the alloy of manganese and copper.



The numbers in brackets are interpolated from the specific resistances of the specimens as observed.

FIG. 3.

86 of copper are adopted. Nickel has the effect of raising the thermo-electric force against copper, besides delaying the bend of the curve of resistance variation with temperature by about 20° C. (see fig. 4). This alloy has received the name of manganin. It is specially made at the Isabell Foundry for standard resistance coils. Fig. 5 shows the change in resistance of a 1-ohm coil of manganin at various temperatures; the observation-points on the curve are numbered for purposes of reference.

From the curve given in fig. 3 it appears that there are only two alloys of nickel and copper for which the temperature coefficient vanishes. The relative merits of these two alloys remain to be studied. Messrs. Basse & Selve, of Altena, who have made all the sample alloys for the Reichsanstalt throughout this investigation, make an alloy with 40 per cent. of nickel, corresponding to the first coincidence of the curve with the abscissæ axis, and they have given this alloy the trade name of "constantan."

Important as is the production of an alloy possessed of a vanishing temperature coefficient, such an alloy cannot be adopted for standard coils until the permanence of the specific resistance has been firmly established. Experiment seems to have proved that manganin and constantan are, in this regard, as suitable as patent nickel. In considering other properties, the thermo-electric power against copper comes first under notice. The table given below fig. 3 shows that manganese-copper has only small negative values for this power; this can be got rid of altogether by adding a trace of nickel to the alloy. On the other hand, nickel-copper, and especially constantan, have high thermo-electric power against copper; these are given in micro-volts in fig. 2, for different proportions of nickel.

The recorded values were determined by soldering the ends of the specimen wires to copper wires that were connected to a galvanometer. All the wires were contained in an oil bath kept at constant temperature by a heating spiral and a stirring wheel. The thermo-electric power disturbed the resistance measurements, especially when low resistances and strong currents were employed. It is true that these defects can generally be eliminated by care in the construction of the apparatus, but for resistance measurements of great precision, it is almost essential to have a material such as manganin, for which the thermo-electric power against copper is *nil*.

Manganin is rather easily oxidised; this, no doubt, is due to the affinity between the manganese and the oxygen of the air. At 100° C. the wire soon tarnishes, and during annealing, the surface manganese is perceptibly oxidised out of the alloy, leaving a surface of copper beneath the oxide. As might be expected, the electrical qualities suffer in consequence. The surface of copper can be removed by "dipping" in nitric acid, after which the good qualities of the manganin are restored.

Surrounding the manganin with powdered charcoal during heating does not sufficiently preserve it against oxidation. Moreover, dipping in acid is impracticable with the finer wires. At first this question of rapid oxidation at annealing temperatures presented a great difficulty to manufacturers of manganin wire, but the wire drawers have now learnt how to draw manganin cold, even to very fine gauges, so that the trouble is very much lessened. By varnishing the finished coils with shellac, it is found that the wire is rendered proof against oxidation, at any rate up to 150° C.

Constantan, on the other hand, resists oxidation. It can be heated with impunity up to 300° C. On account of its strength and flexibility it can be drawn into fine wires or rolled into strips. For many electrical purposes—for instance, where considerable heating is to be expected—the qualities of constantan are of great value; but for standards of resistance manganin takes preference, chiefly because of its small thermo-electric power against copper. In jointing manganin wires to the copper connecting pieces for standard resistances, tinman's solder was previously used, applied with a soldering iron. But this method is found to be detrimental; it produces in the course of time very perceptible changes in the resistance. The soft solder causes fissures, and generally alters the structure and properties of the manganin. The present method employed is to solder the wires with silver solder to copper lugs that are screwed under the contact pieces, so that they can be removed if necessary. All coils, after varnishing several times with shellac, are dried for some hours at 140° C. In winding, the insulated wire is not touched by the hand, but is passed through a clean dry cloth. The bobbins are made of as large diameter as possible, and other precautions are taken to avoid bending of the wire. It is often found better to use several thinner wires in parallel than a single thick one.

CENTRAL STATION PLANT ON BOARD SHIP.

In connection with the, of late, frequent reference to the extravagances of auxiliary plant, we note the remarks of Mr. W. S. Aldrich in a recent paper read to the American Society of Naval Engineers. On board ship the distances are so small that line losses are negligible. They are not, however, negligible in the case of steam. Compressed air is perhaps the best means of storing energy on board ship. Hydraulic accumulators as well as secondary batteries are dismissed as quite unsuitable. Electricity alone seems altogether suitable to economically transmit power from a central point where engines of economical type can be installed near to the source of steam. The power plant should consist of a number of similar self-contained units. The range of power will be less on any one unit than on the several steam engines used to drive scattered auxiliaries. On board ship there can also be arranged very steady loads, and the plant may run day and night at nearly uniform load, the light by night being set off during the day by additional motor loads, while certain pumping machinery can be operated at any time to compensate for unavoidable load variations. The one in charge of such a plant could, in fact, so work it as to secure a load curve the envy of a shore station manager. Quoting from *Transactions American Institution Electrical Engineers*, Vol. xiv., it is shown from Mr. Foster's paper that plants above 200 H.P. show a remarkable uniformity in the fixed charges of interest, depreciation, taxes, and insurance. Operating expenses gradually decrease in plants from 200 to 1,000 H.P., above which they remain very uniform and irrespective of load variations. Large stations supplying many smaller industries are scarcely affected by the instantaneous load changes. On board ship the mains can be safely and securely run through watertight bulkheads, and generally the system is, like the cables, most flexible. Only distribution losses on branch circuits need to be considered in detail. Main line losses are too small for consideration. Direct current in all cases is to be used. Distant motors can be controlled with known certainty from the central point. The author states that there is not a single auxiliary which cannot be electrically operated with certainty, efficiency, and economy, and he enumerates all fans, pumps, blowers, hoists, shifting and steering gear, turret gear, and gun mounts as daily reaching towards the system of electrical operation, also the air compressors for refrigeration purposes.

JOINT TEST: AN ACCUMULATION NULL METHOD.

By E. RAYMOND-BARKER.

In all joint tests hitherto employed two operations are necessary. Whether in Clark's *accumulation*, the *discharge*, or the *electrometer* methods, the main feature of the test lies in the comparison of two deflections.

These deflections are proportional to the amount of current which, in a given time, has leaked into or out of a condenser or into an electrometer, through the respective dielectrics of joint and standard core.

In practice, indeed, frequently three operations are gone through, viz., testing loss on (1) trough; (2) trough and joint; (3) trough and standard core.

It is quite possible, especially in work at sea, for atmospheric conditions accompanying the two main operations of a joint test to be not perfectly constant. Brine laden squalls, intermittent with sunshine, will cause variation of leakage, which scouring of ebonite would seem, at times, powerless to wholly get rid of.

For these reasons a test in which both joint and standard core are tested simultaneously, would appear to have points in its favour. It was under the influence of this idea that —some two years ago—the writer devised the subjoined test.

The accompanying diagram shows the connections of this test which is practically an *accumulation null method*. T is a double trough of ebonite. The usual precautions are taken as regards good insulation, and to prevent leakage between the two trough compartments.

The core with the joint, and an equal length of similar and perfect core, are laid in their respective compartments and are immersed in salt water. The joint will previously have been hardened in ice or freezing mixture.

P_1 and P_2 are copper plates for effecting connection between the water in the respective trough divisions, and the instruments.

C_1 and C_2 are two mica condensers of equal capacity, each, say, one microfarad.

K_1 K_2 is a Price mixing key (shown as a Lambert for ease of illustration).

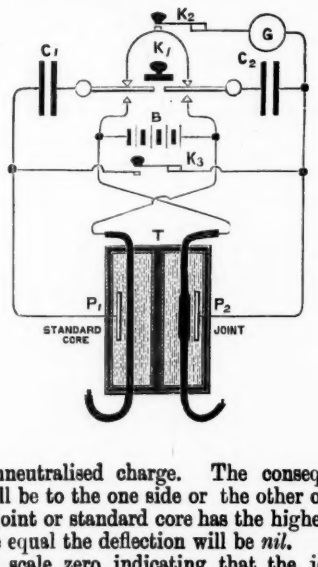
K_3 is an ordinary make-and-break key.

G is a sensitive mirror galvanometer.

B is a battery of high voltage.

For the test, K_1 is depressed during a certain fixed time, say, for one minute. The current leaks through core and joint respectively into C_1 and C_2 in which charges of opposite polarity accumulate.

K_1 is then raised, allowing the accumulated opposite charges in C_1 and C_2 to mix and tend to neutralise. K_2 and K_3 are at once depressed, thus discharging through G any



residue of unneutralised charge. The consequent deflection throw will be to the one side or the other of scale zero, according as joint or standard core has the higher insulation. If the two are equal the deflection will be *nil*.

The side of scale zero indicating that the joint has the higher resistance can be decided once and for all with any given arrangement of instruments, by simple experiment with two lengths of core or leading wire of known inequality of insulation; or, again, by testing for loss on the trough with an artificial leak on one side of the same.

For the joint test proper, when a considerable length of cable may be in circuit with the joint, C_1 and C_2 ought each to be short-circuited until K_1 has been depressed. C_1 and C_2 are then simultaneously unplugged, this operation determining the moment from which the time of charge is to be noted.

By the use of slides or of two high resistances, one being adjustable, this test may be modified so as to afford a perfect *null* method.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Two interesting papers occupied the Institution at its extra meeting on Thursday, April 28th. Mr. H. F. Parshall presented a detailed review of his practical experience of the return circuit in electric traction in his paper, "Earth Returns for Electric Tramways," while the question of return feeders was dealt with by Major Cardew and Mr. A. P. Trotter in a joint paper entitled, "Notes on Electric Tramways."

After the papers had been read, Mr. Gadsby opened the discussion by referring to Mr. Parshall's statement that, where lead-sheathed cables run parallel to earth returns of tramways, the results have been entirely unsatisfactory, since, in the absence of bonding, the lead sheathing is rapidly eaten away. The serious difficulties which arise with such cables makes them unsatisfactory indeed; holes as large as a shilling are sometimes eaten out by the return currents; in tropical climates, where the soil is dry for the greater part of the year, it is found that when rain does fall, and these places are exposed to wet, the cable breaks down. Mr. Gadsby thinks that track welding will be adopted for all tramway work in the next few years; where cast-welded bonding is adopted, good results might be obtained by permitting the metal to overflow or run out at the other side, so as to raise the temperature of the rails sufficiently, but it is a mistake to try and get the weld on so as to have an extremely small amount of clearance. Where rails are laid on white oak sleepers on broken stone, as is the practice in the United States, the conditions are different from what is customary in the country, where a concrete foundation is put in, and there is not much likelihood of trouble with the latter system.

Mr. Gadsby has designed a rail with a separate tread, with the idea of renewing that part of the rail which is subject to wear, and of making the tread of the most durable grade of steel. By stepping and breaking the joints the rail can be made to bond the tread and the tread the rail. With reference to the apparatus and method used in measuring the resistance or joints and rails in position, Mr. Parshall has not stated if or how the resistance of the shunt or parallel path provided by the earth between the test points has been allowed for.

Coming to Major Cardew's paper, Mr. Gadsby considered that it would be impossible to apply the "different voltage" arrangement to a complicated tramway system, but there seem to be some cases in actual practice where the use of feeders of different resistances might be of use.

A certain tramway, not 100 miles from London, exhibits certain interesting features. The tests taken as set forth by Board of Trade Regulations give for the drop in the rails a figure not more than 1 volt, but the leakage to the earth-plate shows 10 per cent. of the total current, the explanation of this being that the generating station is over 300 yards from the line, and an insulated feeder runs from the station or power house to the line terminus. On this feeder there is a drop of from 5 to 6 volts, with the result that the whole of the rail system is some 4 or 5 volts above the earth.

Another speaker referring to the cast-welded joint, thought that it should be bonded electrically, otherwise it does not prove at all a successful system; while Mr. Heaviside described an experiment he had made showing that rails must be insulated completely if it is desired to prevent currents flowing through the earth.

Mr. A. J. Lawson thought that Mr. Gadsby did not recognise the effects of pipes in the subsoil, and the circumstances he had mentioned might be not altogether, but only partially due to the cable in the return, as water and other pipes being connected across and buried in different soils leading up to the generating station would modify the direction of current flow.

A mixed contribution, partly Prof. Ayrton and partly Prof. Perry, followed. Prof. Perry had sent his remarks in writing to Prof. Ayrton for submission in the discussion, and as the speaker and the writer did not always hold the same opinions, the result was somewhat amusing. Prof. Perry thought the most important explanation in the paper by Mr. Parshall was his experience that well-made bonds do not increase in resistance. The exposed surface of the rails is very large, some 50,000 square feet per mile, and the consequences of this should be carefully considered by electrical engineers. Again, in the interests of the companies, Prof. Perry would say that the return should be insulated; whether there should not be a rule, for example, that *all* electrical conductors should be insulated, even though it is known that the Board of Trade rules will partially protect pipes, &c., buried in the ground. New York and Boston have already insisted upon this point—the extra expense need not prove excessive. Prof. Perry ventured to disagree with Prof. Ayrton as to the degrees of importance of educational or teaching institutions being guarded against disturbance from earth currents. Magnetic observatories, however, suffered severely. The value of all records of the Washington Observatory is now destroyed, although two miles away from the source of disturbance, while those of Toronto are useless. At three-quarters of a mile the variations may amount to a half or more of the diurnal variations it is desired to record. While a laboratory may be protected, it is impossible to defend an observatory, and if Kew were interfered with, no money compensation would be commensurate with the damage inflicted. There seems to be no other way in which to obtain a knowledge of the cause of the earth's magnetism than the study of magnetic records.

Then there is the amount of harm that may be done by uninsulated returns to pipes and lines in their neighbourhood. When sewage was cast into rivers the general rights of the community suffered, and steps were taken to prevent future interference. As Prof. Ayrton has before stated, he repeated again, that the use of earth returns was an evidence of conservative feelings of the human being. As earth returns are used for telegraphy, it seems natural to some that we should bring back the current of tramway lines in the same way. There is a talk about zero pressure on the return lines (and of apparatus for effecting this). Who wants them to be at zero? Why should one interfere with the pressures at all? It is an old-fashioned idea that one must do everything by the same means. In ancient days a hole in the roof of a hut let in light and allowed smoke to escape, in later times separate provision was made.

Prof. Ayrton has mentioned on previous occasions that all the railway companies which had Bills in Parliament for the construction of underground railways near South Kensington had undertaken and did insert clauses to the effect than an entirely insulated system would be employed; all had given undertakings that whether a two or three wire were used every bit of the system should be insulated to the satisfaction of the City and Guilds of London Institute and the Science and Arts Department, and had agreed to their right to see that the undertaking was duly carried out. It was to the interest of the companies, who could then construct their lines with best consideration from a purely engineering point of view. Not only would other people not be disturbed, but an enormous benefit would be derived by the companies.

Prof. S. P. Thompson agreed that a standard laboratory should not be interfered with. It was true that Toronto can no longer make magnetic records, but a student's teaching institution is on quite a different footing, and he saw no reason for protecting a laboratory of this kind; rather let the students find out what occurred. He did not apparently favour the plastic bond, and urged the absolute inadvisability of having anything to do with quicksilver. Referring to the thermo-electric effect which interferes with resistance measurements such as Mr. Parshall had taken, he pointed out that the Peltier effects suffered reversal when the testing current was reversed. As Mr. Parshall did not find the tests unaltered by change in direction of current, this was evidence of something else that was not mentioned, as one did not have symmetry. Again with respect to "gathering" the resistance of a conductor is a minimum when the current flows equally through the cross-section, and it is obvious that the useful section diminishes close to a bond, but the professor was utterly astonished to find the "gathering" resistance was represented by 39 inches of good steel rail and hardly thought that "gathering" could be responsible for all that. He thanked Major Cardew for his clear account of how to keep down the drop by return feeders and boosters.

Prof. Thompson was aware that there had been much grumbling at the Electric Lighting Act of 1882, but it is now regarded as a blessing in disguise, as it has saved us from a great deal of abominably bad work: the Board of Trade Traction Rules are a blessing, and not this time in disguise—one need not have quarrelled with them on question of economy had they been more severe than they are.

Mr. Wordingham had come to the conclusion that there was no alternative in some cases to insulating the return. A great objection to slot and conduit systems was the length of time the highways had to be closed for laying—three weeks to a month. Insulated overhead returns had resulted in failure.

Mr. Parshall replied by urging the survival of the fittest.

The four rails of a tramway system represented 6 square inches of copper conductor. The "hole-in-the-roof" argument suited him perfectly; on his basis the hole-in-the-roof became the roof itself! He explained how some of the tests in his paper had been taken, his remarks may be of interest to those who read the paper and reply together in the *Journal*.

Major Cardew briefly replied: He thought that the disturbance at an observatory would depend very largely upon the angle subtended by the tramway at the observatory.

The meeting then adjourned, after a notice by the President that the next paper would be on "The Prevention of Interruptions to Electricity Supply," by Mr. Leonard Andrews.

CORRESPONDENCE.

Carbon Brush-holders.

With reference to the historical note in the first paragraph of Mr. Scott's article on "Carbon Brush-holders" in your issue of the 22nd ult, I may say that although carbon, as Mr. Scott says, does not appear to have been very much used on dynamo commutators until 1892, I remember it being experimented with in the early part of 1889, and largely adopted later by the West End Street Railway Company, of Boston (U.S.A.), on their street railway motors of Bentley-Knight, Sprague & Thomson-Houston constructions.

The use of this material was a decided success, and relieved those in charge of the running of a lot of anxiety owing to the small amount of attention necessary; sparking being practically overcome and wear on the commutator hardly noticeable.

The almost universal adoption of carbon brushes at the present time for street railway work provides ample proof of their superiority on all points over metal brushes, and electric traction engineers have certainly much to thank Prof. Forbes for in suggesting the use of such a satisfactory material.

It is a small detail certainly, but one that has assisted towards making electric traction the success it is.

Gus. C. Lundberg.

April 30th, 1898.

"Generation of Electricity at Gas Works."

According to the *Daily Mail*, January 26th, 1898, there are in the United Kingdom 433 private gas companies, 208 municipalised gas undertakings, the majority of which are at the present time making a considerable profit from gas and the by-products or wastes.

During the year 1897 an application for provisional protection for "Generation of Electricity at Gas Works by Utilising the Waste Gases and Heat," was passed by the Patent Office, and the applicant is of opinion that it is possible to generate 30 to 50 units of electricity as well as 9/10,000 feet of coal gas from a ton of coal as well as the usual by-products, coke, &c.

If such is possible, what will be the ultimate cost of electricity?

The capital expenditure of these gas undertakings is stated to be about £66,500,000, and the expenditure on electrical central stations is increasing so fast that the figures can hardly be correctly stated; but it is certain that a large amount expended on land and buildings, if it were possible or practicable to make gas and electricity at the same works, would be saved, besides which there would be considerable saving in the departments of distribution and collecting.

Another feature is the question of Dowson or power gas, made from cheaper coal, having less illuminating but greater motive power; and the combination of some of the systems would obviate the necessity of storing the electricity, which forms the most costly part of an electrical undertaking when "works' cost" is calculated.

The great increase of electrical traction, and the comparative low cost and advantage of electrical motor power and its distribution, and the question of "day load" may be solved by utilising gas works for the production of electrical light and power as well as illuminating and power gas.

All this hinges upon one question: Is it possible or practicable to utilise the present waste gases or heat at gas works for the generation of electricity?

Also, whether the gas companies, which for many years have supplied us with light, heat, and power, are to be superseded?

Now, as many municipalities are owners of the gas undertakings, and have applications for electric light, would it not be worth their while to consider these questions?

Gas engineers have been studying how to improve their light, and electrical engineers how to cheapen theirs, and both have overlooked the fact that it is possible to produce gas and electricity at the same time from the same coal.

What the public want is cheap and good light, heat, power, and quick transit, and the profits thereof to go to the reduction of the rates, and it may be found practicable by combining the production of gas and electricity at one and the same time at gas works.

Sam. Thos. White.

Bristol.

Free Wiring.

In an article on this subject by Mr. V. Zingler, commencing in your issue of the 22nd ult. and concluding in the current number, it is argued that it is fairer for the consumer, who has the wires and fittings put in for him free of initial cost, to pay in proportion to the actual use he gets out of them rather than for the length of time these goods are in his house. In other words, that it is an all round better arrangement for him to pay a little extra on the cost of the units for the use of the wires and fittings rather than a fixed sum per quarter per lamp put in. I cordially agree with the writer, and feel convinced that the plan which is fortunately being most generally adopted is the one which will work out best in practice, and I hear from the Midlands that a very marked improvement has now been brought forward, which I suppose was not seen when free wiring was first introduced. I refer to the charge for free wiring being made ½d. per unit after the first hour's use at 1d. on the maximum demand basis. This exactly meets the point which Mr. Zingler brings forward, when he says that it may be urged that just as it is found profitable to give the customer a rebate on the cost of electricity after a certain consumption per diem, so it would most likely also be advantageous to all parties concerned to give him a similar rebate on the excess sum per unit for wiring and fittings, the point at which this rebate should come into operation being determined by the sum representing fair interest on capital sunk required from him. Just as when you take a cab for a short trip it costs you 1s., but for a 3-mile run the fare is 1s. 6d., so with the improvement in the free wiring tariff to which I have alluded the customer is not discouraged, by the additional charge for the free wiring, from running his lamps freely and for many hours each day.

Geo. J. Somerville.

Visual Telegraphy.

We have read with mingled feelings of amusement and surprise the numerous and sensational press announcements regarding the alleged invention of Herr Szczepanik.

From interviews with him recorded in *Black and White* and the *Illustrated London News*, we observe that he claims to have originated the idea of employing vibrating mirrors in an apparatus for transmitting views or images of distant objects by electricity.

We may say, however, that as long ago as 1890 we conceived the same idea, and in letters of that date addressed to, and now in the possession of, Dr. Charlton Bastian, F.R.S., we fully described the method whereby this visual telegraphy could be accomplished provided certain mechanical difficulties in the construction of the necessary apparatus were successfully overcome.

Our experience is that the difficulty lies in mechanical construction only, and when Herr Szczepanik has solved this problem he will, indeed, have invented something new.

In the absence of proof to the contrary we must certainly claim to be the originators of the idea of using vibrating mirrors, which, however, is not of much value until some means have been invented for causing them to vibrate at a greater speed than has ever yet been attained mechanically, as in order to reproduce a picture on a screen six inches square with a single electric circuit, the mirror would have to make at least 90,000 (ninety thousand) distinct and intermittent movements in each half second of time, and even at this speed the picture would appear very blurred.

In addition the 90,000 movements of the mirror at the receiving end should be absolutely synchronous with the 90,000 movements at the transmitting end.

We foresee the possibility of reducing the above speed to as little as 300 (three hundred) distinct movements per half second, but then the difficulties of synchronising throughout the longer period of each movement become immensely increased.

It appears evident, therefore, that something more than vibrating mirrors must be thought out before "pictures of battle-fields, &c., can be reproduced at a distance with all the clearness of the cinematograph" (*vide Black and White.*)

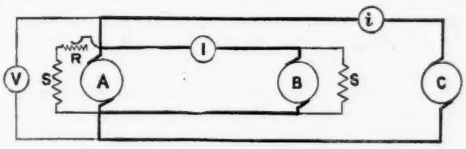
Chas. O. Bastian and A. J. Parsons.

Testing the Efficiency of Direct Current Machines.

On page 548 of your issue of April 22nd appears a reprint from *L'Eclairage Electrique*, by Mons. P. Dupuy, on a method of testing the efficiency of two similar direct current machines. Am I not correct in stating that M. Dupuy is in error in his method of calculating the efficiency? This same test is described briefly by Prof. S. P. Thompson on pp. 759 and 760 of the fifth edition of "Dynamo Electric Machinery," Mr. Kapp being given as its originator.

The formula there given to obtain the efficiency of either machine is:— $\sqrt{\frac{\text{I}}{\text{I}+i}}$, not $\frac{\text{I}-\frac{i}{2}}{\text{I}}$ as M. Dupuy has it; where I is the current in the machine running as motor, and i that supplied by the third machine.

M. Dupuy seems to have overlooked the fact that the currents in the two machines are not equal, except when mentioning the Joule effect, where, unless I misunderstand



A, Motor; B, Generator.

him, he makes the currents to be $\text{I}+i$ and $\text{I}-i$, whereas they should be $\text{I}+i$ and I, that in the motor being in excess of that in the generator by the amount supplied by the third machine.

The efficiency obtained is, I take it, that of either machine at an output situated somewhere between the arithmetic mean and the root mean square of $\text{I}+i$ and I, being nearer the latter the larger the load. With the figures instanced by M. Dupuy the efficiency should be $\sqrt{\frac{1,000}{1,160}} = \cdot 929$, instead of $\frac{1,000-80}{1,000} = \cdot 92$, and the difference between the two methods becomes more marked with a lower efficiency, for instance, with I = 1,000 amperes, as before, let i = 300 amperes, then the efficiency would be ·877, whereas M. Dupuy would make it ·85.

I have been using this test for some time past in the works with which I am connected, both for obtaining the efficiency and as a handy means of applying a load, and can most fully endorse M. Dupuy's statement as to its convenience. I have found, however, two objections to it, (1) the speed drops below normal; (2) the weakening of the field of the motor is conducive to sparking, especially on tooth-cored armatures. An easy way of lessening the latter effect is to connect the field coils of the generator (when it possesses more than one) in parallel, and to insert a resistance, cutting this out, and so strengthening its field simultaneously with the weakening of that of the motor; but this unfortunately still further reduces the speed.

M. Dupuy speaks of keeping the external resistance as low as possible, but with machines of large output and low voltage, it is almost impossible to avoid a sensible waste on the leads, switch, and ammeter, which can easily amount to 1 or 2 per cent.

A very approximately correct allowance may be made as follows:—Measure the watts, w, wasted externally, then if V be the voltage of machines, $\frac{w}{\text{V}}$ represents that part of i for which this loss is responsible, add half this amount to the generator current and subtract half from the motor current.

$$\text{Efficiency} = \sqrt{\frac{\text{I}+\frac{w}{2\,\text{V}}}{\text{I}+i-\frac{w}{2\,\text{V}}}}$$

Example:—

Generator current I = 500 amperes, i = 100 amperes.
Motor current = $\text{I}+i$ = 600 amperes, w = 1,600 watts.

$$\text{V} = 80 \text{ volts}, \quad \frac{w}{2\,\text{V}} = 10$$

$$\text{Efficiency} = \sqrt{\frac{500+10}{600-10}} = \cdot 93,$$ instead of working out to ·913 where these losses not taken into account.

The test is as applicable to compound machines as to simple shunt, but care must be taken that the series turns on the motor as well as those on the generator, are connected cumulatively, otherwise the arrangement lacks stability.

H. B. Poynder.

THE STRATEGIC VALUE OF CABLES.

The present regrettable state of affairs between Spain and the United States, which is a matter of the gravest interest to the whole civilised world, not only on account of the immediate conditions brought day by day before our notice, conditions to which no one can be indifferent, but also on account of the consequences which must inevitably follow when the struggle is concluded, and the time comes for re-adjusting the balance. This situation brings home to us in a practical way a lesson which we should not ignore, although it is not bought by our own actual experience. There are doubtless many points of importance in the war now going on to which the attention of the strategist, naval or military, may be directed with advantage; and there are new problems in politics being evolved which will sooner or later have to be dealt with, but we wish to confine our view to what may seem comparatively a detail of the present complications; yet one which is of the greatest moment, and on which at any time the fortune of war may turn. We have on several occasions laid before our readers our views as to the conditions to which submarine cables are subject in time of war, and have given instances of the invaluable part which these are sometimes called upon to play in such circumstances.

It may, perhaps, be within the recollection of some, that on the occasion of the meeting of the "Convention for the Protection of Submarine Telegraph Cables," which took place in Paris as far back as in April, 1884, a favourable opportunity for establishing the neutrality of cables in war time was unfortunately lost. The result of this convention, at which all the great powers of the world were represented, was a common agreement which, however useful to restrain and penalise wilful damage to cable property in time of peace, did worse than nothing for their protection in time of war.

By formulating and agreeing to Clause XV. of this convention a liberty of action was proffered to belligerents, of which some of them, at least, would have hesitated to avail themselves had not this clause been generally assented to. This portion of the convention reads as follows:—

"*Article XV.*—It is understood that the stipulations of the present convention do not in any way restrict the freedom of action of the belligerents."

It has been said that in case of war cables would be cut when and where necessary, without regard to proprietorship and to after consequences, but whatever moral restraint may have existed before this convention was concluded, or whatever fear of arousing prejudice, if not of provoking actual armed intervention, may previously have existed, has been quite done away with by the *carte blanche* given in the convention. Let us examine the position as it actually stands at present. It is of the utmost importance to each of the combatants that they should have speedy and accurate news of events as they occur, relating to the position and movements of war vessels, the transport and landing of troops, and reports as to the success or failure of the various operations of war. Here Spain is heavily handicapped, as the cable routes by which information may reach the United States are none of them under Spanish control, whereas the cables which united Florida with Cuba, the property of an American Company, are under the control of the United States authorities at Key West. From this point communication with the fleet off Havana, some 90 miles away, can be easily and quickly effected; thus giving the United States a great advantage. The other cable route to the South of Cuba, *via* Bermuda and Jamaica is, we believe, still open, and the line from New York through Hayti to Santiago de Cuba, which belongs to a French company is still working; although it is doubtful if the Spaniards are likely to make use of a cable which lands at New York.

However, we gather from a recent report of proceedings in the Cortes that Spain has taken "the necessary steps to maintain communication." As far as Manilla is concerned there is a single cable from Hong Kong, which until last month was landed at Cape Bolinao and connected with the town of Manilla by a landline some 130 miles long. In consequence, however, of this landline having been cut by the insurgents, the cable was removed from Cape Bolinao and carried direct into Manilla. This cable was interrupted a few days ago, and it is rumoured that the end has been taken on board an American vessel at Manilla for the purpose of establishing direct communication between Admiral Dewey's fleet and the United States; for the truth of this rumour we do not pretend to vouch.

We have on previous occasions given instances of the part played by telegraph cables during various wars, and have shown with what facility these can be destroyed in shallow water. In April of 1882 we published a detailed account of the various occasions on which damage was done to the cables on the west coast of South America during the Peru and Chili war, and the effect thus produced in the course of that war.

We in England have not yet had much practical experience on this subject, it is true that during the bombardment of Alexandria the lines across Egypt, which form the principal link in our means of communication with India, China, and Australasia, were cut by Arabi's troops, but this was little noticed at the time, as telegrams could still be sent to the East across the landlines through Persia, or *via* those which run through Russia and Siberia. Circumstances have changed since that time; we learn that at present the Russians are displaying great activity in Northern Persia, and it is not improbable that in time of need we may find both the Persian and Siberian lines closed against us. Since the time of the bombardment of Alexandria a ring of cables has been put round Africa, which joins the submarine telegraph route to the East at Aden, thus avoiding dangers in Egypt; but these cables are notorious for the frequency with which they break down,* and could not be relied on. Some advantage might be gained by laying a series of cables to Cape Colony, *via* Ascension and St. Helena, and this course has been recommended as one having great strategical advantages. We cannot, however, lend much support to this theory, as this means of communication would be subject to the same danger which threatens all the existing cables to Africa, India, China, and Australasia, it would be liable to be destroyed at the mouth of the Channel in the vicinity of Cherbourg and Brest, where, for more than 150 miles, all these cables lie in water of a depth varying from 40 or 50 to 100 fathoms, a depth at which the cables could be cut with the greatest of ease. We have frequently pointed out the advantages which would be derived by laying a cable from Canada to Australia through the Pacific; a route far removed and naturally secured from the dangers to which the existing cables are subject in many portions of their length. Sir Charles Dilke, who is looked on as an authority in these matters, has said that British cables which followed our trade routes could be patrolled. This sounds convincing, but in time of war it is likely that the Navy will have enough on its hands without telling off a large number of vessels to sail at long intervals along the lines marked down on charts as cable routes. Apart from the lack of foresight evident in this there is an obviously false economy, as the cost of establishing independent and widely separated systems of cables would only be a fraction of that entailed by building a large number of additional cruisers to carry out a patrol duty; which, at the best, would be of little or no use as far as the protection of cables is concerned.

* There are at present interrupted no less than four of the cable sections forming portion of the route to the Cape, *viâ* the West Coast of Africa; these are the cables connecting Mossamedes and and Cape Town since April 14th, Benguela-Mossamedes since April 20th, Kotanu-St. Thomé since April 27th, and San Thomé-Loanda since May 4th. Thus, with one exception, all the cables from the Gold Coast to Cape Town are now interrupted. The cable from Sierra Leone to Accra which broke down on April 9th has since been repaired. None of the cables above-mentioned are duplicated.

ELECTRIC TRACTION AT BRISTOL.

Decision of the City Council.

The Bristol City Council, since our last issue, has, at two special meetings, devoted in all no less than six hours to the discussion of its relations with the Bristol Tramway Company with regard to the directors' scheme for extending their system, and working the whole of their lines by electricity. At last matters appear to have so shaped themselves that both the company's Extensions and Electric Power Bills may proceed practically as unopposed measures, except on one point—that with regard to the fares chargeable. It may be that the Sanitary Committee and the company will come to an understanding on this subject in the next few days, but in the light of past experience this is not very likely, and the Parliamentary Committee before whom the Bills come will have, therefore, to decide between the two bodies as to what the fares shall be upon the numerous lines affected. Mr. George Pearson, the chairman of the Bristol Civic Electrical Committee, who was throughout these long debates the spokesman for the sanitary authority, maintained, and other speakers supported his view, that when carefully examined, the Tramway Company's concessions to the city, as a *quid pro quo* for the sanction to use Bristol streets, would be found more apparent than real. The reduction of the fares for general passengers to the rate of three farthings a mile made very little difference in the present arrangements, and on many important sections no difference at all. The company had the prospect, it was argued, of making an immense saving in their working expenses by the use of electric traction throughout their system, and Mr. Pearson contended that the present price of the shares in the company showed what large profits were expected from the use of electricity. With the hopes of these enhanced profits, investors were willing to pay such a price for shares, that the return to them was only £2 13s. 3d. per cent. per annum. As these profits were to be earned by the use of the public roads, it was urged that the Sanitary Committee were perfectly right in their view that there should be a wayleave paid by the company to the city, and a substantial reduction of fares. On the pro-tramway company's side Alderman Inskip was, as before, the chief spokesman, and his main point was that under 11 heads terms had been provisionally arranged between the company and the chairman of the Sanitary Committee, and that these ought to be taken as the bases of settlement rather than to risk by further demands electrical travelling facilities the citizens needed badly. The Council carried his amendment by 32 votes to 30 in the teeth of the recommendations of the Sanitary Committee, and this amendment worded as follows became the substantive resolution:—"That the Bristol Tramways Extension Bill 1898 be allowed to proceed, and the opposition of the Corporation to the Bristol Tramways Electric Power, &c., Bill, 1898, be withdrawn upon condition that the Bristol Tramways and Carriage Company insert in the Bill proper provisions for giving effect to the stipulations Nos. 1 to 11 in the report of the Sanitary Committee, and such other provisions as may be considered necessary for the protection of the public interest, and that the additional stipulations suggested by the last paragraph of the report be not adopted by the Council."

This last paragraph thus thrown aside was:—"Your Committee are of opinion that no arrangement would be satisfactory which does not reserve to the Corporation the right to veto the use of the overhead wire system in certain areas, and provide for the payment by the company of a moderate wayleave for the use of the streets and a greater reduction of fares."—The conditions, 1 to 11, referred to in the resolution, were as follows:—

1. The company are to be allowed to generate electric current and to use the overhead system upon all the existing tramways, and upon the extensions, on condition that if any other system of electric traction, which may appear to the Council to be an improvement on the overhead system, is adopted and worked at a profit of 5 per cent. or upwards on the capital employed, in five or more towns in the United Kingdom, of a population exceeding 100,000 (any district in the County of London under the control of a Vestry, being regarded for the purposes of this condition as a town), the company will adopt that system on notice from the Council, provided that the mileage of the tramways on which the improved system is adopted is approximately the same as the mileage of the company's electric tramways; and provided the Board of Trade decide that, having regard to the length of the company's unexpired period, it is equitable that the company should make the change. Any question as to the approximation of mileage to be settled, in case of difference, by the Board of Trade.

2. The posts and overhead wires are to be subject to the approval of the Corporation, without appeal, as in the Act of 1894.

3. The power of the Corporation over the execution and maintenance of works in the streets is to be the same as in the Act of 1894.

4. The company are not to supply electric current to other companies or persons within the city.

5. The Corporation are to have the right to use the company's posts for supporting public electric lamps.

6. The company are not to be entitled to require the Corporation to supply them with electricity.

7. Of the first additional capital required by the company for the construction of the works authorised by the Bills not less than £200,000, whether issued by means of shares, debentures, or debenture stock, is to be raised in such a way that the rate of interest thereon shall not exceed 4 per cent.

8. Where owners may be required to sell parts only of scheduled properties, the onus of proof that the part can be severed from the remainder without material detriment thereto, shall be on the company.

9. The fares are to be reduced to rates of about three farthings per mile for ordinary passengers, and one-third of a penny per mile for persons (men and women) of the labouring class. The hours for running labouring class tramcars are to be extended so as to include the hours at which women are employed at factories go to work.

10. The time at which the Corporation may first exercise their power of purchase is to be 17 years from May 1st, 1898, and the subsequent periods of seven years, at which the power of purchase recurs, is to be reckoned as from the expiration of the said 17 years. The purchase is to include the whole of the company's undertaking within the city at the time of purchase, whether consisting of tramways or light railways, except the Hanham Light Railway.

11. The construction of the extensions is to be obligatory on the company.

An attempt was then made by several influential members of the Council to add to these 11 conditions to which the company had already agreed, a demand for a wayleave, and it was moved as a further amendment that the company pay to the city 50 per cent. of their net profits after providing for a sinking fund and paying a dividend of 7½ per cent. on their ordinary shares. (The company pay at present partly working by horse-power and partly by electrical power 6 per cent.). This was warmly debated, but was defeated by 34 votes to 30. Then there was a suggestion that children should be charged halfprice as on railways, and this resulted in an insertion in Alderman Inskip's proposal before the words "And subject to such other provisions" of the following clause: "And subject to the scale of fares to be charged being agreed upon between the company and the Sanitary Committee, or failing such agreement to be settled by the Committee of Parliament to whom the Bill shall be referred." This was accepted by Alderman Inskip, and by the Council generally. As the Bills reach the committee stage next week, there was no time for the Sanitary Committee to report the negotiations on fares to the Council, and it was understood the effect would be a contest on the point in the Committee Room of the House of Commons. The company, in a statement, announce that the average distance a passenger is entitled to travel under their proposed fares is 1 mile, 2 furlongs, 5 chains, 76 links for 1d., or ·75d. per mile. By workmen's car the average distance would be 3 miles, 3 chains, 89 links for 1d., or ·32d. per mile. Workmen's cars are, however, run at fixed times only, and are not numerous.

MUNICIPAL ELECTRICAL ASSOCIATION.

A MEETING of the Association was held at the Westminster Palace Hotel, London, on Monday, April 25th, at 9.30 a.m., to consider and report upon the clauses having the attention of a joint committee of the two Houses of Parliament. The President, in opening the meeting, expressed regret that the notice sent out had been so short, but the clauses for consideration were so important that it was absolutely necessary the matter should have immediate attention. He then called upon Alderman Higginbottom, of Manchester, who had devoted a very considerable amount of time to the subjects to be considered, and who would be able to give them, he was sure, a very clear explanation of the effect of the clauses. Alderman Higginbottom then carefully explained the clauses to the Association, and explained the course which had been taken by Manchester, Glasgow, Nottingham, Sheffield, and several other Corporations who were represented by counsel before the joint committee. The President then said he would put the clauses one by one to the meeting, and would ask them to consider the same separately.

Clause 1.—"Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act, 1882, powers should be given in any case for acquiring land compulsorily for generating stations; and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners, and otherwise.

Resolved, that powers for acquiring land compulsorily were desirable, and that such powers should not be coupled with special conditions as respects liability for nuisance excepting as provided for in the Railway Acts.

Clause 2.—Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply.

Resolved, that compulsory powers of acquiring land for generating stations should not be given without the consent of all the local authorities affected.

Clause 3.—Whether, in case of a generating station, however acquired, not being situate within the area of supply, power should be given for the breaking up of streets between the generating station and the boundary of the area of supply.

Resolved, that compulsory powers for opening up streets between the generating station and the boundary of the area of supply should not be given without the consent of all the local authorities affected.

Clause 4.—Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities, involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any and what conditions should be imposed.

(*a*) With respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act, 1888.

(*b*) With respect to the relations of the promoters to other undertakers, and to local authorities within parts of the area.

Resolved, that no powers should be given for the supply of electrical energy over an area including districts of numerous local authorities without the consent of the local authorities affected, and that no special conditions are required, as the Board of Trade have all powers necessary.

Clause 5.—Under what conditions (if any) ought powers to be conferred upon promoters seeking to supply electrical energy to other undertakers and not directly to consumers.

Resolved, that powers should be conferred upon promoters to supply electrical energy to other undertakers by agreement.

It was further resolved that a witness be appointed to appear before the joint committee to represent the views of this Association as expressed at this meeting, such witness to be selected by the council.

Mr. Gibbings, the president of the Association was appointed by the council to represent the views expressed at the meeting.

LONDON COUNTY COUNCIL.

ON Tuesday the Industrial Schools Committee reported that the cost of substituting the electric light for gas at the Feltham School would, according to the advice of the electrical engineer who had been consulted on the subject, necessitate an expenditure of £6,000. The committee did not, therefore, feel justified in recommending such a large outlay, and their suggestion that £800 should be expended on reconstructing the gas works at that school was adopted.

The Bridges Committee mentioned for the information of the Council that they had accepted an offer of Messrs. Laing, Wharton and Down, amounting to £234 14s. 3d., for wiring the brackets and removing the old lamps in connection with the alteration of the position of the lamps in the open approaches to the Blackwall tunnel. The same committee reported the receipt of tenders, a list of which is given in another column, for the lamp columns, &c., required for the electric lighting of Waterloo Bridge.

The Council, on the recommendation of the Building Act Committee, approved plans submitted on behalf of the Charing Cross and Strand Company for an extension of the generating station in Commercial Road, for the erection of a generating station in Penrose Street, Walworth, for the Vestry of Newington, and for an extension of the Bankside station of the City of London Electric Lighting Company.

The Highways Committee reported having received a reply from the Postmaster-General on the subject of the application of the Council, under the Telegraph Act, 1892, for a license to empower the Council to provide a municipal telephone service for London. The reply stated that it would not be competent for the Council, without obtaining the sanction of Parliament, to construct the necessary works and carry on telephone business at the cost of any funds over which the Council has any control. The Postmaster-General further stated that he must await the report of the Select Committee to be appointed by the Government to consider the question of empowering municipalities to undertake telephone exchange business.

The Highways Committee announced for the information of the Council that the Board of Trade had decided to grant the application of the Vestry of Marylebone for an electric lighting provisional order, and that the orders applied for by the County of London Electric Lighting Company and the Marylebone Electric Supply Company for powers in the same parish of Marylebone had been refused.

It will be remembered that towards the end of March, as mentioned

in the Electrical Review at the time, that the Council decided to ask the Board of Trade to insert, in each of the electric lighting provisional orders which might be granted in this or any future session, a clause for the protection of tramways already purchased or likely to be acquired at any future period. In this connection the Highways Committee reported that the Board of Trade had expressed the opinion that full protection was afforded to the Council by the provisions of the Electric Lighting Act, 1882, and the orders made thereunder, by which the Council, as owner of the tramways, would have power, subject to certain conditions, to alter the position of electric lines or works which would interfere with the lawful exercise of any powers vested in the Council, the Board pointed out that Section 15 of the Act provides that where the position of any electric lines or works is altered, compensation shall be made or secured to the owners. In these circumstances the Board regretted that it was unable to insert in provisional orders the clause suggested by the Council.

LEGAL.

Weblyn *v.* Shoolbred & Co.

The case of Weblyn *v.* Shoolbred & Co., was down for hearing in the Queen's Bench Division on Monday, May 2nd, before Mr. Justice Hawkins and a special jury. Mr. Fletcher Moulton, Q.C., Mr. Roger Wallace, and Mr. Gaskill were counsel for plaintiff, and Mr. Lawson Walton, Q.C., M.P., and Mr. Ernest Pollock for the defendants. The action was brought to recover damages for the destruction or partial destruction of a valuable picture, entitled "The Royal Harem," which was on exhibition in the Strand during the latter part of the Jubilee Year.

Mr. Fletcher Moulton said the damage, which was by fire, was alleged to be due to the negligence of the defendants, in consequence of their having put in an installation of electric light in a defective way.

His Lordship (alluding to a vast array of models and electric lighting apparatus in the Court) asked if the case was a patent case. Was all that electrical apparatus to be used before him and the jury? If so he thought it was hardly a fit case to go before a jury.

Mr. Lawson Walton said the defendants were anxious that the case should be tried before his Lordship and a jury.

His Lordship: I don't know how you purpose to do it; for you may have experiments to make.

Mr. Fletcher Moulton said there was no doubt it was a technical case, but he thought there would be no difficulty in making either his Lordship or the jury fully acquainted with the facts of the case on which they would have to form conclusions as to what was done in connection with the electrical installation.

Mr. Fletcher Moulton said that if his Lordship expressed an opinion that it was not a suitable case to be tried before him and a jury, they would communicate with their respective clients. Both sides were very anxious to have the case tried.

His Lordship: I do not think it is a case that could be reasonably tried by a jury or by anybody who has not had some opportunity of making some experiments himself.

Mr. Lawson Walton said there were two issues on which a verdict was desired. The first was whether the installation was carefully and correctly done, and the second was whether the fire was caused by the defective installation or had some other origin. He thought that that would involve the calling of considerable electrical evidence.

His Lordship suggested that it would be better for experts to make the experiments elsewhere and then give evidence. If there was any likelihood of fire being caused by the experiments he should prefer that they should not be performed in his presence.

After consultation it was agreed that Mr. Fletcher Moulton should take an order referring the matter to an official referee or arbitrator within a fortnight. The parties, with their models and apparatus, and electrical experts, of whom a large number had been subpœnaed, then left the Court.

Crossley Bros. *v.* Johnson.

At the Greenwich County Court on Friday, before his Honour Judge Addison, Q.C., Messrs. Crossley Bros. sued Mr. W. Claude Johnson, of the Dignaries, Westcombe Park Road, Blackheath, for £21 17s. The sum of £5 was paid into Court by the defendant, who urged that the balance was expenditure caused by the act of the plaintiffs' own servant. From the evidence it appeared that on May 13th, 1897, the plaintiffs sent a workman named Frank Turner to effect certain repairs to the gas engine which worked the dynamo of defendant's private electric light installation. He arrived a few minutes before the dinner hour of the defendant's workman, Suckling. The engine was working at the time, but when Suckling left for dinner he stopped it, and Turner commenced to do his work. Whilst he was removing some bolts from the gas engine it began to work, and Turner noticed sparks on the switch on the wall which turned the electricity from the dynamo either direct to the lights or to an accumulator as might be desired. Turner ran for Suckling, who came and tried to turn the switch, but in consequence of its being partly fused he could not do so, and the engine was finally stopped by Turner who threw off the belt, causing the piston to fall out and the damage, for the repair of which the claim was made, was thus sustained. The plaintiffs' contention was that the switch was faulty, and when put by Suckling, on going to his dinner, at the neutral position, fell to one which allowed the current, in the usual course under such circumstances, to flow back from the accumulator to the dynamo, which thereupon worked the engine, or in the words of his Honour, "the tail wagged the dog." They also contended that Suckling, upon leaving the engine room, should have lifted the brushes of the dynamo, which would have rendered the action impossible. For the defence it was contended that Turner must have handled the switch himself, but his Honour held this to be most unlikely, and found a verdict for the plaintiffs.

Kibble *v.* Harrison Patent Knitting Machine Company.

This case which came before Mr. Justice Bruce and a common jury at the Manchester Assizes last week, was a claim for breach of contract. Plaintiff was a comedian living in Manchester, and he complained that some electrical work undertaken by defendants for him was executed so badly that he was deprived of a pantomime engagement at the Shakespeare Theatre, Liverpool. The result of this was that he was out of an engagement during a winter season, and incurred heavy expenses in the reconstruction of the work done by defendants. The defence was that the company was not responsible for the way the fittings were made, and that defendants made them perfectly right for the required work. Plaintiff gave defendants an order for the illuminating and wiring of certain dresses, and also for the five batteries required to work them. An engagement was procured with the above theatre subject to the trials of the show being satisfactory. Defendants then informed plaintiff they would not be able to supply a portable battery, but that a stationary one would serve the purpose and the wires would be invisible. When the trials were made the so-called invisible wire, which counsel said was like a piece of clothes line, was used. The trial was a complete failure. The ladies had their wings on all right, and the plaintiff had his battery in the flies with the invisible wire to work it. The first thing they noticed when the thing commenced in the limelight was that the invisible wire stood out even more conspicuously than in the daylight. The next thing they noticed was that lamps on the demon's dress would not light, and plaintiff got his hand burnt. As regards the ladies' dresses some of the lights went out. Although they were angels their lamps were fixed with bitumen, which melted, and the lamps then fell off. As the result of the trial, the manager of the theatre at Liverpool told the plaintiff that "the thing was off," and the engagement was then cancelled. Mr. Harrison, manager of the defendants' electrical department, afterwards apologised to the plaintiff, and said his experiment had been tried and had failed.

Mr. James Hill, a Manchester electrician, spoke of examining four pairs of wings and the demon dress in December last. The lamps in the wings were fastened with some stuff like bitumen, and upon these being lighted the heat generated would have a tendency to soften the bitumen and cause the lamps to fall off. He explained how the defects arose, and said the light was caused to flicker through an intermittent contact. He did not consider the fittings of the demon dress a workmanlike job. He considered it was possible to make a proper installation, and to construct a portable battery for the demon dress without a prior experiment.

Mr. Sutton, on behalf of the defendants, submitted that the fault did not arise from the work they did. So far as the wings were concerned, the defect was on before it ever came into their hands. As to the demon dress, the defendants simply undertook to supply the things that it required when it was brought to them, but they did not undertake to overhaul it, and be responsible for it.

Mr. H. W. L. Harrison swore that the plaintiff and he had been in partnership in Peter Street, Manchester, as electricians for stage purposes. Plaintiff worked on the electrical part of the demon dress, and subsequently, when they dissolved partnership, he brought it to him and asked him to put the lamps on it. Plaintiff frequently came to him and went into the workshop and examined the dress while the work upon it was in progress, and expressed his satisfaction with it when it was completed. All the lamps were lighted in Manchester before it left the defendants' hands, but at the trial at Liverpool they would not light. Any displacement of the wires would prevent the lighting.

After further hearing the jury returned a verdict for the plaintiff for £50, and judgment was entered accordingly with costs on the County Court scale.

BUSINESS NOTICES, &c

Auction Sale.—Messrs. Percy Huddleston & Co. are to sell by auction the contents of the Copper Depositing Works, West Ferry Road, Millwall, E. This is in connection with the General Electric Power and Traction Company (in liquidation) *v.* Lewis. See our "Official Notices" this week for particulars.

Bankruptcy Proceedings.—An application was made on Wednesday to Mr. Registrar Brougham at the London Bankruptcy Court for an order of discharge on behalf of John Dewhurst, electrician, &c., 52, North End Road, West Kensington. The bankrupt failed last February with provable debts £590, and assets that will realise in all about £200. He attributed his failure to the excessive amount paid to a late partner, to a loss of £130 through embezzlement by a traveller, and to depreciation in the value of the stock-in-trade as estimated for a forced realisation. The Official Receiver reported the following offences, viz., insufficiency of assets to pay 10s. in the £ to the unsecured creditors, imperfect books, and misconduct in not having at once disclosed to the Official Receiver and Trustee the whole of his (bankrupt's) realisable assets. After hearing Mr. White in support of the application, the learned Registrar imposed a suspension of three years.

Electrical Wares Exported.

Week Ending May 3rd, 1897.	£	s.	Week Ending May 3rd, 1898.	£	s.
Albany	112	0	Amsterdam	25	0
Amsterdam	85	0	Auckland	43	0
Antwerp	68	0	Barcelona	298	0
Auckland	47	0	Bordeaux	18	0
Bombay	509	0	Boulogne	169	0
Buenos Ayres	150	0	Calcutta	42	0
Calcutta	236	0	Cape Town	1,673	0
,, Teleg. mat....	19	0	Durban	466	0
Cape Town	1,272	0	,, Teleg. mat. ...	672	0
,, ,, Teleg. mat.	2,263	0	East London	31	0
Colombo	24	0	Flushing	19	0
Durban	500	0	Fremantle	200	0
East London	59	0	Lisbon	402	0
Flushing	31	0	Mauritius	73	0
Fremantle	637	0	Melbourne	35	0
Hamburg. Teleg. mat.	50	0	Monte Video	50	0
Melbourne	22	0	Penang	24	0
,, Teleg. mat.	23	0	Port Elizabeth... ...	410	0
Nagasaki	91	0	Stockholm. Teleg. mat.	435	0
Ostend	34	0	Sydney	148	0
Passages	1,935	0	Yokohama	1,393	0
Perth	488	0	,, Teleg mat.	3,000	0
Port Elizabeth... ...	225	0			
,, ,, Teleg. mat.	389	0			
St. Petersburg. Teleg. mat	543	0			
Singapore	67	0			
,, Teleph. mat.	7	0			
Sydney	823	0			
Teneriffe. Teleg. mat.	558	0			
Townsville	25	0			
Wellington	370	0			
Yokohama	222	0			
Total ...	£11,872	0	Total ...	£6,631	0

Foreign Goods Transhipped.

		£	s.			£	s.
Brussels.	Elec. motors	150	0	Barbadoes.	Teleph. mat.	43	0
				Barcelona	... ...	11	0
Total ...		£150	0	Total ...		£54	0

Birmingham Exhibition.—The Electrical and Trades Exhibition at Bingley Hall closed last Saturday night.

Books Received.—"Steam-Boiler Construction: a practical handbook for engineers, boiler-makers, and steam-users." By Walter S. Hutton. Third edition, carefully revised and enlarged, by the addition of 175 pages and 194 new illustrations. Price 18s. Crosby Lockwood and Son, Stationers' Hall Court, E.C.

"Submarine Telegraphs: their history, construction, and working." By Chas. Bright, F.R.S.E. Published by Messrs. Crosby Lockwood & Son, London. Price £3 3s.

Brown, Boveri & Co.—On April 1st Messrs. Conrad Baumann and Sidney W. Brown were made partners in this well known concern.

Catalogue.—The International Trading Company, of 35, Queen Victoria Street, E.C., who are sole agents in Great Britain and the Colonies for Herr G. Wehr, Sohn, Berlin, have issued a well illustrated catalogue of telephones, microphones, telegraph instruments, electric bells, batteries, and a variety of electrical accessories. The numerous articles are arranged in table form and numbered for easy reference, and the letterpress pages are followed by about 30 pages which are devoted exclusively to illustrations.

Commutator Bars.—Our readers will remember that about six or seven months ago a correspondence took place in our columns in which it was demonstrated that there was room for improvement in lists of stock sizes of commutator bars. We have now received a new list published by Messrs. Thomas Bolton & Sons, for whom it has been prepared by Mr. Theodore Stevens, E.M., A.I.E.E., which ought to prove of considerable utility to designers and makers of dynamos. The list contains over 70 pages of tables which are divided off into three sections: Table I. enabling the dimensions of the bar of any commutator to be easily calculated; Table II. giving a list of sizes arranged according to the number of sections in the commutator; and Table III. giving a list of Bolton's stock sizes arranged according to their dimensions. Messrs. Bolton will send a copy of this useful little book to any electrical engineer who applies at the offices at 90, Cannon Street, London.

Concert.—The Dover Electricity Supply Company held a staff smoking concert on Wednesday last week.

Country House Lighting.—The electric light has recently been installed in Mr. Wood's house at Gwernyfed Park, South Wales. About 180 lights have been fixed, the plant consisting of an oil engine and dynamo with a battery of D.P. accumulators, provision being made for water power or a second oil engine as an auxiliary. The work has been carried out by Messrs. Drake and Gorham.

Dissolution of Partnership.—Messrs. C. Geary and J. Hall, trading as electrical engineers at Swadlincote, under the style or firm of Hall, Geary & Co., and at 164, Corporation Street, Birmingham, as the Birmingham Electrical Accessories Company, have dissolved partnership by mutual consent. Debts will be attended to by Mr. John Hall, and the business carried on under the same name as heretofore.

Foreign Trade.—We have sometimes thought it would be interesting to know to what extent our foreign trade is affected by the official reports of our consuls abroad. The great value of periodical reports of the outlook, accompanied by business hints from official quarters, needs no emphasis in our columns, for we believe many manufacturing and merchant firms who trade with foreign parts, but who, for divers reasons, have not establishments in those countries, have found them of much assistance. During the past few years they have become an essential to the foreign trader, whether from choice or necessity, and with the increasing commercial rivalry between ourselves and other countries they promise to become even more important.

But we have no monopoly in a matter like this, and competitive countries have also their consular trade reports, and we have no doubt that in these any particularly good points noticeable in our business methods are emphasised for the benefit of our competitors, in the same way as we ourselves are kept informed of the efforts of German and other traders with a view to following their example so far as may be practicable.

Electrical manufacturers in this country undoubtedly have plenty to do at the present moment, but a good supply of home orders should not lessen the desire for export business. Everything that can be legitimately done to extend our foreign electrical trade should be taken advantage of.

As a rule we suppose the first thing to be done in the cultivation of a trade with any new district is to watch the opportunity and make a market where none existed before, and having done that, to see that the requirements of that market are catered for in the most thorough manner possible. Were this done, the likelihood of being outdone by foreign rivals would, we venture to believe, be smaller than at present, although the Englishman prides himself upon the fact that his markets are open to all comers, be they friends or foes. That we are not mindful enough of the markets where we should have supremacy is clear, from the remarks of several of our consuls, and we are occasionally thought to give far greater attention to the article ordered than to the man who has ordered it. From one standpoint this is a satisfactory charge, and its outcome is a better quality of goods supplied. The complaint is not that the quality ought not to receive so much attention, but that the customer and the probable customer should be more considered. For instance, it has been attributed to the Englishman that he declines to depart from certain lines and standards of manufacture which he has himself laid down. His manner says, "Take it or leave it; my goods are suitable for home consumption, and they should be good enough for you." But are they? Does it follow that because a thing is suitable for use in England, it can be just as easily applied in the service of the Heathen Chinee? He may be behind the times, but that is not the point, it is a matter of business; and when a man asks for a thing it is the manufacturer's work to supply that specific article if it is at all possible.

What is the result? The German or American trader comes along, and when questioned whether he can supply such and such a thing which his British competitor fails to do, sees a splendid opportunity for ousting his rival, and by hook or by crook he will take and execute the order. The customer does not fail to take a note of all this, and though in the long run he may prefer to deal with the Englishman for other reasons, he for the time being trades with our rivals, and a blow is struck at our supremacy. Mr. Cusack Smith, the British Consul at Samoa, in his report on the trade of the islands during last year, despises the system of circularising which is so largely adopted by our manufacturers, and belauds the personal representation which we have over and over again recommended in these columns. He considers a day's work done by a "civil, ingratiating, well-informed traveller" more than equal to five years' persistent circularising, and quotes a curious instance of German methods in those parts: A German commercial traveller recently visited Samoa with excellent samples at marvellously cheap prices, and obtained £2,000 worth of orders, mainly from British traders, but most or many of his goods were originally made in Manchester. These were ordered by German firms, and marked in Germany with German trade marks, and were sold by the German traveller with the remark: "The English manufacturers won't send out the goods, so we do it, and make the profit." Mr. Cusack Smith says that this only emphasises the folly of "not sending out British travellers," and he declares that British trade will suffer far more severely during the next five years from German competition than it has done already, unless British manufacturers attack the colonial and foreign markets in the energetic, well-organised, up-to-date, and conciliatory manner adopted by the Germans.

A financial contemporary the other day remarked, in connection with this matter, that it is not easy to understand why British manufacturers should be so slow to act upon the advice, in the main sound and practical, conveyed through the medium of our consular reports.

German houses go in for a very high standard of education for young men who lay themselves out for commercial pursuits, and our consul at Stettin recently drew attention to the great service rendered in this direction by the Stettin Commercial Association, which was opened about 27 years ago. One of the objects of this association is to send young men out abroad to the British colonies, America, and elsewhere, to improve their knowledge of business, and to work in the interests of Stettin trade, a free grant of about £75 being made to each man for the purpose. At least 50 of these grants have been made, and the German consul of each country visited was informed of the arrival of the student. Here is a form of organised competition which might do untold harm to the business of this and other

countries. It should be well digested by Englishmen. What can be the value of mere circularising in the face of such facts as these?

American houses by no means ignore British consular reports, and for that reason we can hardly afford to completely ignore theirs. The American Resident and Consul-General at Bangkok recently addressed some important remarks on the trade opportunities of Siam, a part of the world, by the way, which receives some attention at the hands of American electrical contractors. He draws attention to the splendid field offered for development, and advises special efforts to be made to increase the trade of the United States with this rich and prosperous kingdom of South-Eastern Asia. A critical period is approaching, and the results thereof will determine the control of Siamese foreign trade.

The report says that exporters of Europe have fully awakened to the importance and possibilities of Siam's markets, and adds:—

"After a residence of four years in Siam, I think that here is one of the best opportunities for the United States to build up a trade that is afforded anywhere in the world, considering, of course, the population and area. But all efforts to induce American exporters to enter these markets have been unsuccessful. Letters have come in unlimited numbers, to all of which careful attention has been given; catalogues have arrived and been distributed where they would do the most good; questions asked have been answered in detail; and many reports, general and specific, have been sent to Washington and duly published for the benefit of the exporters and manufacturers of the United States; but still there is a most discouraging lack of interest. This interest should be evidenced by sending to Bangkok experienced and capable representatives to carefully investigate the field, secure trial orders, and establish reliable agencies. In this connection, three facts are worthy of note: First, not more than six qualified representatives of American houses have visited Siam during the past three and a half years; second, almost without exception those that have come have been surprised at the extent and opportunities of the market, and have gone away with satisfactory orders, or, at least, with sufficient to pay expenses; third, in the same period no less than 100 capable representatives of European firms have visited Bangkok, and, in 90 per cent. of the cases, have done very well.

"Catalogues are valuable in their way—invaluable, in fact—but too much reliance is placed on them. They do not discuss the matter with the buyer; they do not answer all his inquiries; they do not obviate his objections to trying a new firm, a new class of goods, or to giving up his relations with some European house which has supplied him for years. If firms which are rich enough to publish the elaborate catalogues, which they issue annually, would devote even a small portion of that expense to sending energetic, educated, and tactful representatives to the far East, they would obtain far more substantial returns."

Some important facts are mentioned in the *Consular Journal*. It is to be hoped, says our contemporary, that our electrical engineers and our public works contractors are fully alive to the field for enterprise which China is now affording. It is, of course, too much to expect that China will now awaken completely from the comatose condition in which she has lain for centuries, but that she is exhibiting greater signs of vitality, owing to the action of the Powers, than she has ever done before is not to be denied. Her rulers are, it seems, learning to appreciate the truth of the scriptural injunction that it is no use kicking against the pricks, and European enterprise has pricked her coast-line sorely of late. The municipal authorities of towns like Shanghai, Pekin, Tientsin, &c., are therefore taking steps to establish electrical tramways, and tenders will presently be invited for undertaking these works. The Shanghai authorities, says a Consular correspondent writing to us, have already adopted the following resolution: "That the Council be, and is hereby, authorised to consider the expediency of establishing a system of electric tramways in the settlement." Our contemporary's correspondent urges electrical and other engineering firms to send out representatives or appoint agencies.

Langdon-Davies Motor.—The business of the Davies Motor Company, of 16, Red Lion Street, Clerkenwell, has been transferred to the Langdon-Davies Electric Motor Company, Limited. This company has taken premises at 101, Southwark Street, S.E., where there is every facility to enable them to cope with a fast increasing business. The entrance floor of the building affords room for spacious showroom and offices, and in the other parts of the building there is ample space for the manufacturing department. The workshops are equipped with machine tools and special labour-saving appliances of the most up-to-date character.

London School Board.—The Industrial Schools Committee has been authorised to obtain tenders for the supply of an auxiliary engine, dynamo, and switchboards, and connecting up circuits for direct lighting on the *Shaftesbury* training ship. The engineer's estimate is £950.

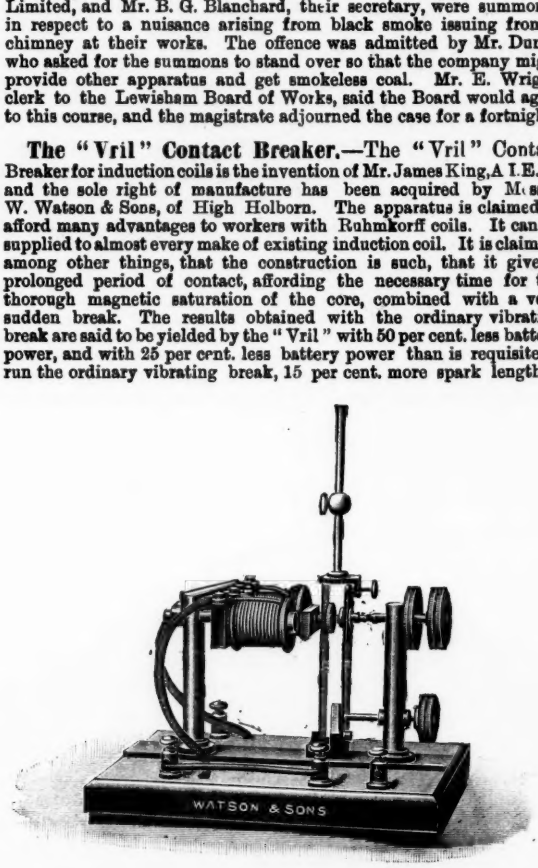
The Microphonograph.—From Mr. G. A. Nussbaum, of 29, Ludgate Hill, who represents La Société Industrielle des Téléphones in this country, we have received a pamphlet describing the new microphonograph which that company has recently brought out. The pamphlet contains an illustrated and general description of the Dussaud microphonograph (Berthon-Dussaud-Jaubert system) and its applications in the treatment of deaf mutes. Some of the illustrations show deaf mutes who are in the seventh heaven of delight upon discovering that by the aid of the microphonograph they are enabled to hear musical and other sounds.

Mill Lighting.—Messrs. W. H. Baughan & Co., of Charlbury, have secured the order for a complete installation comprising dynamo, shafting, accumulators, &c., of the new mills of Messrs. Early & Sons, blanket manufacturers, of Witney.

Personal.—Mr. John Shaw, electrical engineer, of Manchester and Ashton-on-Mersey, has just been elected chairman of the Ashton Urban District Council, and he will thus be entitled to sit on the Bench as a Justice of the Peace for the County of Chester. Mr. Shaw has been a member of the Council since its formation, and in that capacity was enabled to render excellent service when the mains for the electric light now supplied by the Altrincham Electric Supply, Limited, were laid down for the supply of the township. Mr. Shaw was also elected a member of the Sale and Ashton Technical Instruction and other Committees.

Smoke Nuisance.—At Greenwich Police Court on Thursday, the Crystal Palace District Electric Supply Company, Limited, and Mr. B. G. Blanchard, their secretary, were summoned in respect to a nuisance arising from black smoke issuing from a chimney at their works. The offence was admitted by Mr. Dumas who asked for the summons to stand over so that the company might provide other apparatus and get smokeless coal. Mr. E. Wright, clerk to the Lewisham Board of Works, said the Board would agree to this course, and the magistrate adjourned the case for a fortnight.

The "Vril" Contact Breaker.—The "Vril" Contact Breaker for induction coils is the invention of Mr. James King, A.I.E.E., and the sole right of manufacture has been acquired by Messrs. W. Watson & Sons, of High Holborn. The apparatus is claimed to afford many advantages to workers with Ruhmkorff coils. It can be supplied to almost every make of existing induction coil. It is claimed, among other things, that the construction is such, that it gives a prolonged period of contact, affording the necessary time for the thorough magnetic saturation of the core, combined with a very sudden break. The results obtained with the ordinary vibrating break are said to be yielded by the "Vril" with 50 per cent. less battery power, and with 25 per cent. less battery power than is requisite to run the ordinary vibrating break, 15 per cent. more spark length is



yielded by the coil if the "Vril" Contact Breaker be employed. The heating of the platinum contacts is greatly diminished, and does not become very appreciable with a long run of 30 minutes or more; liability to adhere is obviated, and the wear of platinum very much reduced. Workers with Rontgen's X rays will especially appreciate this feature. The speed of the make and break is controlled by means of an adjusting screw. The "Vril" affords facilities for varying the speed of the vibration exactly. It produces the same effect as a mercury interrupter, without any of its trouble and annoyance. The figure shows the breaker mounted on a separate case unattached to the coil.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Gas and Electric Lighting Committee reported to the Town Council on Tuesday, recommending that the electricity mains should be extended to the West End, and that the low tension direct system, with drop of 110 volts at full load, should be adopted, at an estimated expense of £5,750, as recommended by Prof. Kennedy. The Committee suggest that it be remitted to the engineers to prepare specifications and invite tenders for the work. The Committee did not see their way to recommend the Council to take any action in regard to dust destructors at present.

Barrow.—Mr. R. H. Burnett, the borough electrical engineer (late of St. Pancras), commenced his duties on Monday last.

Basingstoke.—The Electric Lighting Committee, after considering terms proposed by Messrs. Warburg, Dymond & Co., for putting down an electricity installation, has recommended the Town Council to apply for electric lighting powers themselves for carrying out the works. This course was approved by the Council.

Bedford.—The Bedford Town Council have decided to increase, by £1,400, the amount of the £4,000 loan they are about to apply for, the addition being made expressly in order that the electric light may be installed on the Market Hill.

Bermondsey.—At Monday's Vestry meeting the report was considered of the sub-committee, which appeared before the Board of Trade on April 27th, when the opposition of the London Electric Supply Corporation, and the County of London and Brush Provincial Electric Lighting Company, to the Vestry's application for an electric lighting provisional order, was heard by Sir Courtenay Boyle. The Committee reported that after the opposition had been heard, Sir C. Boyle asked whether the Vestry intended to carry out the order if granted, and on being assured by the chairman of the Electric Lighting Committee that such was the case, Sir C. Boyle said that the Vestry could have no objection to the deletion of the clause which empowered the Vestry, with the consent of the Board of Trade, to transfer its powers; and this was accordingly agreed upon. Sir C. Boyle advised the Vestry to again consider the financial aspect of the question, and stated that if within 14 days the Vestry decided to go on with the order, he would recommend that the same be granted. The sub-committee recommended that Sir C. Boyle should be informed that the Vestry, after again considering the financial question at his suggestion, respectfully asked that a provisional order should be granted to the Vestry. This recommendation was unanimously adopted.

Bromley.—The Bromley (Kent) Electric Light and Power Company, Limited, who have just acquired the powers formerly vested in the local authority, have, within the past week, made a practical start. A contract has been entered into for the erection of a central lighting station, and at the present time workmen are busily engaged in preparing the foundations. Many of the shareholders are tradespeople and private residents, who have given notice of their desire to be supplied with the light. The contract for the installation has been secured by Messrs. Edmundsons, of Westminster, and one of the first places to be lit is the new Bell Hotel, now approaching completion. The Bromley Company have also entered into a contract with the newly-formed Chislehurst Electric Lighting Syndicate to supply them with current. The secretary of the Bromley Company is Mr. Martin J. Dickins, of the Market Square, Bromley, and, notwithstanding the difficulties experienced in acquiring possession of the order, the future of the company is generally regarded as most hopeful.

Canterbury.—Good progress is now being made with the work connected with the establishment of the electric light here. The whole of the contracts have been settled; the construction of the generating station is well in hand, and the laying of mains is to be commenced in a few days. At the meeting of the Town Council this week the Lighting Committee submitted a schedule of the proposed positions and number of incandescent lamps to be used in public lighting. There are to be 144 on posts and 29 on brackets, the latter of a design costing £3 1s. 10d. a piece. The Committee recommended that the main thoroughfare from St. George's Gate to Westgate be illuminated by means of arc lamps, 12 in all, at an additional cost of about £140. Six separation stations are also to be provided for lighting and extinguishing the arc lamps, at an outlay additional to the estimate of about £707 10s. The contract for wiring the new Reaney Institute for the electric light has been secured by Mr. E. J. Philpot. It is hoped to have the light in use by next winter.

Chorley (Lancs.)—The Corporation have obtained a provisional electric lighting order from the Board of Trade.

Colchester.—The electric light station is to be opened about the month of July.

Colombo.—The contract for the lighting of the public streets and roads of the Fort of Colombo has been given to Messrs. Boustead Bros.

Dewsbury.—The 69 applications for the position of electrician to the Dewsbury Corporation has been reduced from six to three by the Electricity Committee. The final selection will shortly be made. The salary is £250 a year.

Dublin.—The Dublin papers say that on Wednesday evening last week there was a failure in the electricity supply, a number of hotels being seriously inconvenienced. The *Daily Nation* says that "the failure was occasioned by the breakdown of three different engines." That paper also says that several of the hotels are about to take legal proceedings against the Corporation.

Dundee.—The Gas Committee has recommended that the estimate of a Dundee firm be accepted for erecting a new economiser house at the electricity works at £600.

Durham.—A local correspondent says that from Wednesday's Town Council proceedings it would appear that incandescent gas will be adopted for street lighting. The matter of electric lighting *v.* incandescent gas is in the hands of a committee.

Eastbourne.—On Monday the Eastbourne Town Council decided to consult Mr. Wright, the engineer to the Brighton Corporation, anent the public electric lighting works being combined with the destructor. Mr. Wright will be consulted either alone or in conjunction with another expert, who had been approached by the Committee.

Edinburgh.—The Electric Light Committee's provisional estimates for the year ending May 15th, 1899, shows:—Estimated expenditure for 1898-99, £49,250, and the revenue £51,250, leaving a surplus of £2,000 to be transferred to the credit of the rates, after providing £6,000 for reserve fund. Last year the estimate was £33,390, and the revenue £35,455, leaving £2,065 to be credited to the rates, and after providing for £4,000 to be contributed to the reserve fund.

Glasgow.—The Electricity Works Sub-committee recommends the Corporation to adopt proposals which have been brought forward by Mr. Chamen, the borough electrical engineer. The statement, which comes before the Electricity Committee shortly, says that the Waterloo Street station, with its capacity of 3,300 horse-power, was completely overloaded during the fog last winter, and as the increase in the number of lamps fixed had been, on an average of five years, about 30 per cent., this meant, with the erection of over 100 lamps on the Springburn electric tramway route, a necessity for at least 100 horse-power additional. Waterloo Street station being taxed to its utmost capacity, a new site had been purchased at Port Dundas, where work had already been begun, and arrangements had been made for the purchase of another site for a generation station on the south side of the river, near Eglinton Street station. At Port Dundas there would be no difficulty in installing some 30,000 horse-power, and at the southern station another 15,000. The question of distribution had also to be considered. Waterloo Street station was at present distributing current at a pressure of 100 and 200 volts, but the Board of Trade regulations now permitted current to be supplied at 250 and 500 volts, which enabled the current to be carried much farther, and saved very largely in the amount of copper required in the distributing mains and feeders, the saving being about 50 per cent. The new plant already ordered for Port Dundas was designed to supply current at the increased pressure, and the plant for the southern station could be similarly designed. There would be no difficulty in supplying feeding points about two miles distant from each of the new generating stations, and in further supplying an area of about half a mile radius from such distant feeding points. This area practically included the whole municipality, so that there would be no necessity for resorting to high tension current. The use of the increased voltage rendered it impossible to work the new stations in connection with the same mains which at present distributed the energy from Waterloo Street, and so it would be desirable in time to relieve that station of its entire load. The capital expenditure detailed in the report is £551,000, made up as follows: Capital expenditure at present, £150,000; capital expenditure proposed in report, £396,000; cost of removal of Waterloo Street plant, £5,000. The surest way to arrive at a low rate of charge for the supply of electric light, concludes Mr. Chamen, is to make the concern as large as possible, so that the sooner the capital expenditure contemplated in the report is reached the better. He therefore recommends (1) That in addition to the £95,000 to which the Corporation already stand committed, a further expenditure of £61,000 be authorised for the Port Dundas station and mains, and (2) that an expenditure of £108,000 be authorised for the South Side station and mains. The expenditure would be spread over a period of about two years.

Glossop.—A special meeting of the Town Council discussed the electric lighting question last week. A sub-committee of investigation was appointed, with power to engage a consulting engineer. The meeting was adjourned to June 5th, when the question of applying for the provisional order will be dealt with.

Heaton Norris.—The District Council has resolved to apply for a provisional order.

Hereford.—The Electric Light Committee has been empowered to take the necessary steps for providing the electric light for the town. Expert advice will be obtained, and inquiries made *re* site, and on the subject generally.

High Wycombe.—Last Saturday the foundation stone of the electric lighting station buildings was laid by Councillor Wood (chairman of the Electric Lighting Committee of Wycombe Corporation). The company which has been formed to carry out the work is entitled the High Wycombe Electric Light and Power Company, Limited, Mr. Alfred Slatter being the managing director. A site for the electric light station was found in a meadow adjoining Lily's Walk. The buildings have been designed by Messrs. Moxham and Son, of Wycombe, and include a boiler house, engine house, accumulator house, and various offices. The contract for their erection has been entrusted to Mr. Henry Flint, whose tender amounted to £2,383. The contract for the electrical plant has been placed in the hands of Edmundsons Electricity Corporation, Limited, under the supervision of Mr. J. C. Wigham, and of the resident engineer, Mr. Fippard. It is hoped that supply will be ready by July 1st.

Hornsey.—The provisional order has been granted by the Board of Trade with slight alterations.

Hull.—The Electric Light Committee, on 28th ult., decided to recommend the Council to extend the electric light installation of the city into East Hull, at an estimated cost of £25,000. When the extension is made, the circuit of the city will have been completed.

Ilford.—Mr. Hawtayne is to survey certain lands in the district with a view to selecting a site for electricity works.

Islington.—As we have seen several mis-statements regarding the success of the Islington electric lighting undertaking, the following notes will be interesting as being the facts of the case. The Vestry has spent £144,226 capital up to December 31st last, and is now spending a good deal more. The *net loss* last year was £318. The *gross profit* was £4,432, and these figures are good for a business in its second year. The total cost per unit is 3·57d., and to this has to be added interest, &c, amounting roughly to 6 per cent. on the capital invested. As a matter of fact, long before the supply commenced the price of current was fixed, and for public lighting it is 5d. per unit. This covers all charges for current, interest on capital of lamps, &c., repairs to lamps, &c., trimming, erection, management, &c. The 1½d. per unit over works' costs does not quite pay all these charges, so that the supply is quite reasonable at 5d. per unit, and Mr. Hulland, the chairman of the Hackney Electric Lighting Committee, is quite wrong in assuming that the books are balanced by a "cooking" process. Every arc lamp at Islington costs £30—£40 total including *all* costs, as explained above. The Works Committee pay 5d. per unit, and that is all; the Electric Lighting Committee find all plant, labour, lamps, &c, and do all the work, light the streets, &c., and get the sum mentioned as return for *all* and every expense incurred in so doing.

For the quarter ending March 31st, the receipts for the supply of electric light in Islington amounted to over £6,000. The estimated cost of production was £2,700, leaving a gross profit of £3,300. After deducting repayment for loans, there is a net profit of £1,750.

Keighley.—The Corporation is about to approach the electric light question in earnest. A visit was paid to Southport last week, and a provisional order is being applied for.

Lancaster.—The Town Council resolved on April 27th, upon the recommendation of the Electricity Sub-Committee, that the tender of Messrs. Willans & Robinson, Limited, for the supply and erection of a close-type high-speed engine for the electricity works (£1,347) be accepted. The Committee were authorised to accept tenders for a dynamo. Applications for the supply of electricity to Ripley Hospital, the Royal Grammar School, and Bowerham Board School, were granted, subject to guarantees being made that the income from each building would be equal to 15 per cent. on the outlay. With the exception of a few churches, all the principal buildings in Lancaster are now lighted by electricity.

Liverpool.—The Lighting Committee last week agreed upon extensions of mains in various streets at a cost of £800.

Ludworth.—The Parish Council has appointed a sub-committee to inquire fully into the subject of electric lighting.

Mexborough.—The ratepayers will oppose the scheme of the General Power Distributing Company, as in a year or two the district may put down its own plant.

Mitchelstown.—Major Cardew held a Board of Trade inquiry last week regarding the application of the Guardians for a provisional order to light the town with electricity. Mr. Richard O'Driscoll, engineer to the scheme for the Board of Guardians, gave evidence as to the manner in which it was proposed to light the town. The stream from which they proposed to derive the motive power had a horse-power of 17½ on an average. The stream varied very little, though it was occasionally flooded in winter. The average fall in the level would be 3 or 4 feet at the very outside. Major Cardew, quoting from an estimate made by Mr. Harris, of Bray, said he noticed the amount estimated for cost was £825. He afterwards visited the stream, and pointed out that considerable expenditure would be necessary in the making of embankments, and expressed an opinion that a cheaper scheme of public lighting than that now proposed could be adopted with advantage to all parties.

Morley (Yorks).—At Tuesday's meeting of the Corporation Mr. Robert Hammond submitted his report on the progress of the electricity works, which has now been in successful operation for some time. The motor alternator has been returned to Wolverhampton for alteration to the bearings. Mr. Hammond was hoping to be in a position to report that the final tests of the plant had been completed this week, but the contractors have asked to be allowed a few more days' delay. The apparatus for measuring the water is ready, and there is now nothing to prevent the tests taking place at an early date. In accordance with instructions, Mr. Hammond submitted a statement made up to March 31st, showing the commitments on capital account sanctioned by the Local Government Board, £22,500; commitment to date, £20,764; balance of the original scheme still available for mains, extensions, connecting up customers, &c, £1,735 10s. 2d. In November last year, in accordance with the request of the committee, he presented a report on the electric lighting of all the streets through which the mains are laid, and then pointed out that immediate decision on the matter was not necessary, as cable ducts were to a large extent available for accommodating the necessary mains without re-opening the streets. The committee ultimately resolved to order cable for connecting the present arc lamps direct to the sub-stations, instead of the general distributing mains, but to defer consideration of the remainder of the scheme until the works were completed and in operation. Mr. Hammond again brings forward a scheme for the general lighting of the streets where mains are laid. In his previous report he deprecated a mixed scheme of arc and incandescent lighting, and set forth the cost of either type of lighting by itself, for each section under consideration. An extension of the arc lighting might be desirable in South Queen Street and Chapel Hill, but the remaining sections could be best dealt with by means of incandescent lamps enclosed in glass lens reflectors, as at Brighton, Ayr and elsewhere. Mr. Hammond recommended that a trial lamp or two on this system should be fixed in some favourable spot for actual experiment. Mr. Hammond then concludes his report by giving his scheme for lighting, which will cost, with special mains, £650, and without special mains, £575.

Portsmouth.—It is proposed to purchase certain property in St. Mary's Street, Portsmouth, adjoining the electric light station, the space being required for extra machinery.

Preston.—The National Electric Supply Company has reduced its charges for lighting current. The company has adopted 220-volt distribution. After July 1st the price will be reduced from 7d. to 4d. per unit after one hour's use, less 15 per cent. cash. Current for heating and motive power purposes will be 3½d. per unit net.

Provisional Orders.—The Electric Lighting (Provisional Orders No. 1) Bill relating to Airdrie, Brechin, Hamilton, and Rothesay was read a second time in the House of Commons last week.

Ryde.—The Board of Trade have decided in favour of the Corporation *re* the Electric Light and Power Company, and consequently the latter will not proceed with their application for powers to supply electricity to the island borough.

Sheffield.—Judging from the correspondence and comments in the local press, and also the discussion in the Council Chamber, it appears to be true that the public meeting at which the proposed purchase of the electricity undertaking was disapproved, was really "packed" by ironmongers and other tradespeople who might be justly termed interested parties. It seems, therefore, that the poll which is to be held is quite unnecessary, yet it must now be held at a cost of about £1,000. Mr. T. Scott Anderson (of the local electrical firm Scott Anderson & Beit) writes to the local press to say that his firm had nothing to do with the opposition. He says, however, that he, as president of the Contractors' Association, wrote to the Town Clerk asking for particulars as to the Corporation's proposals regarding the clause which gave it the right to manufacture and trade, but to the question whether the Corporation would not compete with ordinary contractors no answer was forthcoming. He questions whether six of the votes at the public meeting could be said to be electrical. He considers the Corporation itself is only to blame, as it has known of the opposition for some time past.

Shoreditch.—At the fortnightly Vestry meeting on Tuesday, Mr. H. Winkler again raised the question as to when the electric lighting accounts, which had been promised, would be placed before the Vestry. In his opinion it was desirable that the accounts should be forwarded generally to the members of the Vestry without going specially before the Lighting Committee. In answer, the accountant stated that the accounts were in the possession of the printers, and that he hoped to have corrected copies ready for presentation to the Lighting Committee on the following day, so as to be brought up at the next Vestry meeting. On behalf of the Electric Lighting Committee, Mr. H. E. Kershaw said they had no feeling in the matter. If the Vestry desired to have the accounts before going before the Committee it could have them; but as it was purely a Committee matter, he thought the figures should go before the Committee in the first instance. The discussion on the subject then terminated. The Lighting Committee announced that they had considered a report from the chief engineer to the effect that he had received three proposals from three insurance companies as to insuring the engines. It was resolved to insure the six engines with the National Boiler Insurance Company for £200 on each engine, at a total premium of £49 13s. The same Committee had had under consideration a report from the chief engineer (Mr. Russell) as to whether it was right to charge the capital cost of the arc lamps and posts to the electric lighting capital account, or whether same should be paid for out of the general rate, as in the case of gas lamps, as some of the work in connection with painting same had been charged to the general rates. The Committee recommended and the Vestry decided that the cost of the arc lamps, columns, &c., should be paid for out of the general rate.

Shoreham.—The Local Government Board is prepared to sanction the £6,000 loan for electric lighting if the District Council obtains the necessary powers, submits plans, and complies with the usual conditions as to information. The Council, on receipt of this intimation on Tuesday, decided to leave the matter in abeyance for the present.

Singapore.—A draft scheme has been submitted to the municipality by Messrs. Moine & Co. for electric tramways and the electric lighting of Singapore. The proposal, says *Indian Engineering*, will be taken into consideration in due course, and if vested interests do not intervene, the Settlement will make a necessary advance in its development.

Southampton.—Last week the Council adopted a report of Mr. Manville's, submitted by the Electric Lighting Committee, in which he recommended public lighting by 62 2,000-C.P. arc lamps for various streets. The standards will also be provided with brackets for two 32-C.P. incandescents for lighting when the arcs are extinguished at midnight. Thirty-two of these lamps will be used in the streets in which both electric lighting and tramways will be combined, and some of the standards will be arranged for both purposes and some for lighting only. Tenders are to be invited for the supply of the steel and iron columns recommended. It is expected that the streets will be electrically lighted by September.

Southport.—The report of the Gas Committee shows that electricity is rapidly superseding gas in that town as an indoor illuminant. The profits on gas for the year have only amounted to £7,000, or £4,000 less than was estimated.

Stafford.—The annual report of the Corporation Electricity Department shows that the consumption of electricity for the 12 months ended March 31st amounted to 52,231 Board of Trade units, as compared with 39,606 units last year, being an increase of 12,625, or nearly 32 per cent. The manager has submitted a short report upon the advisability of doubling the present pressure of the electric supply, and he was authorised to confer with Dr. Hopkinson, and report fully upon the question at the next committee meeting.

St. Helen's.—The Electricity Committee recommends the erection of arc lamps in a number of streets.

St. Pancras.—A very satisfactory statement was placed before the Vestry at the meeting held on Wednesday last week by the Electricity and Public Lighting Committee, in regard to the working results of the electric light works during the year ended December 31st, 1897. The Committee reported that the total revenue for the year amounted to £33,347 19s. 11d., which is an increase over the year 1896 of £6,258 3s. 6d., equivalent to more than 22 per cent. The net profit amounted to £6,517 19s. 9d., which, after writing off the deficit of £800 12s. 7d. brought forward from 1896, left a net profit for the year 1897 of £5,717 7s. 2d. The Committee recommended the Vestry to forward copies of the accounts to the Board of Trade and the Local Government Board, and that from the profits a sum of £4,000 should be transferred to a reserve fund, and that the balance of £1,717 should be carried forward to the accounts for 1898. In moving the adoption of the report, Mr. H. J. Menzies (chairman of the Committee) complimented the Vestry on the very satisfactory results, as exemplified by the accounts, which showed that the early anticipations in regard to the electricity undertaking were, in the main, being fulfilled. If the enterprise had been of a private nature, the past year's results would have yielded a dividend of 6 per cent, and allowed of £3,000 being carried to the next account. The works had sold a larger quantity of current, which had been generated at a lower cost than in previous years. In three years the revenue from private lighting had been doubled, and the undertaking was still growing. The speaker thought it right that the labours of the staff should be recognised. If the stokers had not quite fully earned the bonus promised to them he hoped the Committee would take their case into consideration and make some recommendation. The Vestry should also recognise the work of Mr. Sidney Baynes (the chief electrical engineer), and that of Mr. A. E. Pycraft (chief clerk of the electricity and public lighting department). The Committee, the speaker concluded, could at last see clear water, and he hoped that the confidence placed in them would not be unappreciated.

Tipton.—The District Council has decided not to withdraw its objections to the scheme of the Midland Electric Corporation for Power Distribution. The Council could not agree to the rates proposed to be charged to them by the company.

Wells.—The provisional order of the Wells (Somerset) Town Council expires in July next, and the Council at their meeting on Monday decided to apply for an extension of time. The Gas Company have fitted incandescent lights throughout the town, but during a gale lately they suffered severely.

West Ham.—The Council has issued a notice to the effect that it will commence to supply electric current in various thoroughfares on September 29th.

West Hartlepool.—The Town Council on Tuesday instructed the borough surveyor to forthwith invite tenders for taking out the quantities for the electric lighting station, and ask for the shortest time in which they can be ready; and that upon acceptance of a tender by the committee, he at once advertise for tenders for the plant. The Local Government Board has sanctioned the application to borrow the money, and the Board of Trade has approved of the system. The Mayor remarked that negotiations were proceeding with the tramway company in regard to the light railway to Seaton Carew, and also in regard to the town supplying electricity to drive the trams. He thought the matter would be settled and an agreement signed before long.

Wormit.—A public meeting last week considered the question of introducing electric lighting into the village. A scheme was brought forward by a Mr. Cowley which would cost, for buildings, plant, &c., £3,000, and an annual expenditure of £335. It is interesting to note that a recent canvass of the district showed one ratepayer to be in favour of gas, 12 oil, and 77 electric light. The meeting adjourned for a week, and a committee is to be appointed.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Algeria.—The first line of electric tramway in Algiers was put in operation on 19th ult. The line, which is 10 kilometres long, extends from Bad-el-Oued to Mustapha.

Birkenhead.—The Special Committee appointed to inquire into the question of tramways in the borough issued a report for presentation to the Council on Wednesday. The Committee report that they have been unable to come to any arrangements with the Birkenhead Company as to the surrender of their lease, which expires at the end of 1900, and they had not thought it necessary to negotiate with the Wirral Company, whose lease expires in 1916. Applications had been received since the closing of the negotiations with Mr. Ross from several bodies desirous of running electric trams in the town, but all had been declined on account of the Council's decision in regard to Mr. Ross's proposal. The Committee have unanimously decided that a more extended system of lines should be laid down for electrical trams on the overhead system, and they consider that the Council should settle upon the routes as soon as possible, and they have drawn up a scheme to submit to the Council, so that work might be decided upon and begun as soon as necessary. In arriving at their recommendations as to routes the Committee have carefully taken into account the following general points:—(1) Suitability of the road, *i.e.*, as to probable traffic, interception of branch or side roads, gradients, widths, &c. (2) Possibility of profitable and useful future extension. (3) General requirements of a district. The routes proposed are the Borough Road line, the Dock line, the Higher Tranmere line, the Shrewsbury Road and Oxton line, the Park Road North line, and the Central Claughton line. The surveyor (Mr. Charles Brownridge) estimates that the expense of relaying existing lines, where utilised, and laying down new lines will be about £104,500, and the wires, poles, cars, and installation will be about £77,500.

Bradford.—Some quick work in cable laying was performed between 11 p.m. last Saturday and 6 p.m. on Sunday, in laying the feeders for the Great Horton section of the Corporation electric tramways. The cables were laid by the staff of the electricity department of the Corporation. Four large mains were put down with a sectional area of 1·6 square inch of copper, together with a telephone cable for the tram service, and a "pilot wire" for recording the pressure at different parts of the route. The greater portion of the work was finished for traffic on Sunday evening, a length of 330 yards being completed, equal to 1,980 yards of cable.

Bristol.—On Friday last week the Bristol Tramways (Electrical Power, &c.) Bill, and the Bristol Tramways (Extension) Bill were read a second time.

Bromley.—The Mason's Hill, Bromley, residents strongly oppose the scheme for a light electric railway to be made in four sections, running from Herne Hill to Farnborough, through Dulwich, Sydenham, Penge, Beckenham, Shortlands, and Bromley. The promoters of the railway are the London Southern Tramways Company, Limited.

Ceylon.—Work in connection with the overhead trolley tramways is being pushed forward. Last month the rails were being laid, the power station erected, and part of the plant was ready to put in position. The span-wire system is to be employed.

Chatham and Rochester, &c.—The Light Railway Commissioners finished their inquiry last Saturday in reference to applications that have been made to carry out an electric tramway system for the towns of Rochester, Chatham, Strood, and Gillingham. Unfortunately, the opposition has proved too strong, and it does not appear that for the present anything further will be done in this respect, and thus a great boon has been lost to the whole neighbourhood. For some time past considerable dissatisfaction has been expressed by many at the present omnibus system, which is very inadequate, and it was thought, very properly, that a tramway system throughout the whole district (which comprises a large area of many miles, as all the towns mentioned adjoin one another, and has a population of more than 100,000) would be very beneficial. There was a great deal of evidence given for the trams. Foremost among the opposing parties was Mr. Thomas Aveling (managing director to Messrs. Aveling & Porter, engineers and steam road-roller and traction engine manufacturers). Their works are situated on the Medway's banks, at Strood. The firm employs nearly 1,000 men, and traction engines were constantly going in and out of the works daily. He maintained that the trams were perfectly impracticable in the streets, and would stop their business. Their firm turned out 360 engines in a year. They did a lot of work for the Dockyard and the Royal Engineer Barracks at Chatham, and he considered their engine traffic could not be worked with the trams. Of course the proprietors of the local omnibuses put in a strong opposition. For the purposes of the scheme it had been put forward that the tram company, if formed, would be prepared to assist the authorities to purchase certain properties in order to widen and improve the streets at necessary places. Numbers of people very greatly regret that the proposition has failed, as the district is being continually extended, and the trams would have been a great convenience to all classes.

Cheltenham.—At the Town Council meeting on Monday it was resolved to inform Mr. Bickerdike, of Montreal, Canada, who has applied for a franchise to immediately construct and operate a line or system of lines for electric cars, forming a complete service for the town, that if he likes to make a proposition the Council will consider it.

Colombo.—Work in connection with the construction of tramlines in Colombo is being pushed forward rapidly under the direction of the resident and consulting engineers, Messrs. Beveridge and Etlinger, sen. The poles for the trolley lines are erected.

Dover.—The contractor for the electric tramways permanent way has asked the Dover Town Council to remit the fine of £254 imposed on account of his contract not being completed to time.

Flamborough and Bridlington.—The promoters of the proposed light railway to Flamborough from Bridlington intend applying to the Light Railway Commissioners for an amendment of the order granted in 1897, to enable the company to increase the capital authorised to be raised, and to extend the time for the completion of the construction of the railway and works.

Holland.—Negotiations are in progress with reference to the conversion of the horse tramways in the town of The Hague into an electric line.

Kidderminster-Stourport.—The electric tramline which will start from the railway station in Comberton Road, and passes into the Stourport Road, following the line of highway, and terminating at the Stourport Bridge, will probably be opened by Whitsuntide. The boilers and engines have been put down, and one of the dynamos has been fixed. The cars, nine in number, are all at the depôt. Each car is constructed to carry 40 passengers, and fitted for electric lighting. Some of the cars are specially adapted for summer traffic, having open sides. Matters are so forward that in the course of a few days it is intended to have a trial trip along the line. A Dudley paper gives some notes on the present position of tramway affairs locally. The Light Railway Commissioners have made an order empowering (if it be confirmed by the Board of Trade) the British Electric Traction Company to make two lines—one from the existing tramcar line at Holly Hall to Kingswinford and thence by Wordsley to the bottom of Brettell Lane; another from Queen's Cross by way of Old Hill to the Five Ways at Cradley Heath. On both these lines the order provides for electric traction on the overhead system. The order has to be confirmed by the Board of Trade. Dudley Town Council has intimated its intention of opposing the order, so far as it deals with the portion of the routes within Dudley borough. Of course, the British Electric Traction Company will be represented by counsel at the Board of Trade inquiry, and backed by the other local authorities concerned outside Dudley, namely, Brierley Hill, Stourbridge, Rowley, and Amblecote Urban Councils and Kingswinsford Rural District Council. The inquiry will probably be held in a few weeks' time.

Leeds.—An interesting epitome of the working expenses and receipts for one week in connection with the Leeds overhead electric tramway system has just been published. The total receipts amounted to £656 16s. 4d., the mileage covered being 14,777 miles, the receipts per mile thus working out at 10·66d. The working expenses, depreciation, interest and sinking fund charges usurped 8·60d., thus leaving a surplus of 2·06d. per mile, or a profit of £6,595 per annum. The capital outlay up to date amounts to £138,374. Mr. E. Basil Lupton, a local solicitor, points out in a letter to the *Leeds Press* that the system has so far cost double the original estimate, and that the system is working at a loss. The figures at first sight show a profit; but he claims that an insufficient amount is taken off for depreciation, which should be 15 per cent., and not 7½ per cent.

The Highways Committee has resolved to recommend that the Headingley, Chapeltown, Dewsbury Road and Hunslet sections be equipped with the overhead electric system.

Limerick.—The firm of Zeitz, of Hamburg, are stated to have written to the Corporation in quaint English offering to establish an electric tram system all over the city "without any cost, on getting a lease of the streets." This is cool! We guess many an English promoter would like to get tramway concessions on these terms.

Liverpool.—The Tramways Construction Committee decided on Monday by seven votes to three, to order for use on the experimental electric tramway between St. George's Church and the Dingle 14 German electric cars—seven of the Altona type and seven of the Ring-Bahn type—with trailers to each. The cars, with their trailers, will accommodate 50 persons each. The Committee resolved to leave Sir Arthur Forwood to order 14 other cars from America, provided the specification of the electrical work was altered so as to fulfil the requirements of Dr. Hopkinson, consulting electrical engineer to the Corporation. About four months must elapse before the cars are ready for use. The Committee are desirous of seeing both the German and American cars at work, with the object of adopting a car of their own pattern which they hope to have made in Liverpool.

The City Council on Wednesday refused to agree to the recommendation of the Generating Stations Committee (of which Sir Arthur Forwood is the chairman) to accept tenders for the supply of electrical generating engines of a certain type, whereupon Sir Arthur intimated that he had striven during the last two years to provide the city with a worthy tramway system, but his Committee had not received the support and sympathy of the Council. He, therefore, not only would resign from the Committee, but that would be the last occasion upon which he would be present in that chamber. This is not the first time Sir Arthur Forwood has resigned from the Tramway Committee!

Newark and Worksop.—An important scheme is on foot to construct an electric railway between Newark and Worksop, which will run through a part of the far-famed Dukeries, so popular as a holiday resort. The line in many places will be laid along the side of the highway, and in others across land to be acquired for the purpose. The total length of the railway will be 22 miles 7 furlongs, and the gauge 4 feet 8½ inches.

Newcastle.—At a meeting of the Special Tramways Committee on Monday a discussion took place as to the two experts to be called in to advise on the cable and electric systems respectively. The resolution passed by the Council stipulated that these should not be financially connected with any tramway company or system of trams. Mr. Laws, city engineer, presented a report suggesting the following gentlemen as experts:—Cables, Mr. Callomb, Edinburgh; electric, Dr. Hopkinson, Mr. James Swinburne, and Mr. Manville. After a lengthy debate the matter was adjourned for a fortnight to enable members of the Committee to make further inquiries.

Nottingham.—The proposals of the Corporation to equip the tramways on the electric trolley system were referred to in our April 8th and 15th issues. On Monday last the following resolution was passed unanimously, and the Bill will accordingly be presented to Parliament:—"That the report of the Tramways Committee now presented to the Council be received and adopted as and for the second reading. That the Town Clerk be and he is hereby authorised, under the direction of the Tramways Committee, to take the necessary steps to obtain all such Parliamentary powers and the consent of the Board of Trade, and any other authorities as may be necessary to enable the Council to carry out the works mentioned in the said report, and that the costs to be incurred in so doing be paid by the Finance Committee in such manner as they may deem most expedient."

Paisley.—Detailed notice of the application which is being made by the British Electric Traction Company, Limited, for the construction and working of electric light railways within the counties of Renfrew and Lanark, is published in the *Glasgow Herald* of 23rd ult.

Portsmouth.—Notice has been given of the intention of the Hampshire Light Railways (Electric) Company, Limited, to apply to the Light Railway Commissioners for an order authorising them to construct and work light railways between Portsmouth, Cosham, Purbrook, Waterlooville, and Horndean. One line from Cosham to Horndean is about 5 miles, 7 furlongs, 3 chains in length, and the other, from Waterlooville along the road leading to Bargreen, about 5 chains in length. The gauge proposed is 4 feet 8½ inches, and the motive power electricity. Powers are to be sought by the company to generate, use, convey, distribute, and sell electricity either for power, lighting, heating, or any other purpose. Mr. A. W. White, J.P., manager of the Portsmouth Street Tramways, has taken an active part in promoting the scheme which is regarded with marked favour by the residents along the line of route, and especially at Waterlooville, a popular resort of Portsmouth people during the summer.

Ripon.—The City Council on 28th ult., had the question of tramways before it. The committee, which has been going into the question of the provision of better railway and tramway facilities, has been considering several schemes for cheaper transport between the city and the railway station, and proposed to visit Blackpool and Lytham to inspect the gas and electric trams; but in this the committee was overruled, the idea being considered premature.

Shanghai.—The Shanghai Municipal Council is considering the expediency of the establishment of a system of electric tramways in the streets of the Settlement, and "in its discretion to formulate scheme for ratification by the ratepayers by which the system be carried into effect."

South Staffordshire.—For some years past the local authorities in South Staffordshire have been agitating for an improved method of traction on the lines belonging to the South Staffordshire Tramways Company which traverse all the principal towns lying between Birmingham and Wolverhampton. At length the Board of Trade intervened, and in consequence of representations by the various District and Borough Councils, the tramway company have been pressed to substitute an improved method of traction for the steam engines at present in use. An important conference, convened by the Board of Trade, was held on Tuesday at the Town Hall, West Bromwich, to consider the question. All the local authorities in the district through which the company's lines pass were represented. Col. Marindin, of the Board of Trade, presided. Mr. Schuster, chairman of the tramway company, explained that they were promoting a Bill in Parliament, the cost of which would be borne by the British Electric Traction Company, the object being the introduction of an improved system of traction along the whole of the South Staffordshire routes. Mr. H. Ward, on behalf of the Handsworth authorities, opposed the overhead electric system, and suggested that a cable system should be substituted for steam engines, because passengers from the various Staffordshire towns would be able to travel to Birmingham without changing cars. Mr. G H. Dunn (Mayor of Dudley) explained that in four years the lease of the tramways within their borough would expire, and then it was the intention of the Dudley Town Council to municipalise the tramways. Councillor S. Pitt, Mayor of West Bromwich, said, whilst his Corporation did not object to a further extension of the time for the use of steam by the company, yet they wished the Board of Trade to impress upon the company the necessity of improving the method of traction as speedily as possible. He thought probably the suggestion made by the Mayor of Dudley would be accepted by the other authorities, and if thought desirable they would take over the tramways, and then they could introduce what system of traction they liked. They thought, if they consented to a lease of the existing lines to the British Electric Traction Company for 21 years, it would prove disadvantageous to the interests of the local authorities. Mr. Sellon, of the British Electric Traction Company, explained that it

was proposed to lay down the overhead electric system. Some of the shareholders objected to this, and preferred the conduit system. Ultimately the conference was adjourned for a month, and in the meantime Mr. Sellon undertook to supply the various authorities with full particulars of the Bill which it is proposed to promote in Parliament. The Wednesbury Town Council favour the introduction of the overhead electric system, which has proved satisfactory in other parts of the Black Country.

St. Helen's.—On 27th ult., a Corporation Committee received the Board of Trade's sanction to the £25,000 loan for equipping the tramlines and putting down plant. The inquiry into the matter was held only eight days previously by Major Cardew. The loan is to be repaid in 20 years. The Board was rightly thanked for its prompt and courteous attention to the matter.

Stockport.—The Stockport Corporation, who expect to be able to publicly supply electric light and power in the autumn, have approached the Stockport and Hazel Grove Tramways Company with the object of purchasing the concern and running electric tramways. At present the company shows no disposition to sell on the terms proposed.

The Surrey and Middlesex Light Railways.—The proposal of the London United Tramways Company to apply to the Light Railway Commissioners in June for powers to construct a light railway, with electric traction as the motive power, through Richmond, Ham, and Kingston, to Hampton Court, is threatened with severe opposition. The route proposed will lie through the residential portion of Kew Gardens, Richmond, over Richmond Hill, through Petersham, past the historical Ham House and the Dysart estates, to Kingston-on-Thames, thence over Kingston Bridge to Hampton Court Palace. In Queen's Road, Richmond, where the best class of houses in the borough are situated, the residents in the proportion of about 100 to two, have declared strongly against the proposal, the Parliamentary Committee and the Amenities Committee of the Richmond Town Council have recommended unqualified opposition, and the house agents in the town and the locality unanimously agree that the line if it came would ruin the place as a residential suburb. Upon the other hand, the Mayor of Richmond, a gentleman of close knowledge of the wants of the borough, and a good judge of its future, cannot definitely make up his mind upon the details of the proposal, and such local leaders as Sir Roland Wilson and Admiral Alington have expressed opinions in favour. A petition in Richmond assenting to the scheme has received 1,500 signatures, Avon-on-Kingston has received 2,000, and at Ham, Petersham, and Hampton numerous signatories testify their approval. In Ham and Petersham the public feeling is all in favour, the need of better means of communication being recognised. The Hampton Wick District Council have met privately, and their decision is kept a close secret; but several members have stated their approval of the scheme. At Kingston, the Town Council have referred the question, with the discussion, to their General Purposes Committee, but there is in the borough a feeling of satisfaction at the proposal. Mr. E. J. Halsey, chairman of the Surrey County Council, in the course of an interview, stated that he considered a tramway a great convenience, and he should support it, provided it was not unduly dangerous or inconvenient. The Ratepayers' Association, on the other hand, have met, and expressed the view that the Corporation and the borough should maintain tramways if they were wanted. The second proposal of the company to carry their line to Uxbridge is meeting with approval along the suggested route.

Volk's Electric Railway.—At yesterday's (Thursday's) meeting of the Brighton Town Council, the borough engineer and surveyor's report to the Works' Committee on Volk's electric tramway was considered. It seems that it will be necessary to reconstruct a part of the line on piles to the south of the new widened Madeira Road, the cost of this to Mr. Volk being estimated at £1,500. The Committee considered this a favourable opportunity for reconsidering the existing arrangement between Mr. Volk and the Corporation, and recommended the grant to Mr. Volk, at a yearly rental of £120, of a lease of the arch he occupies for his machinery, dynamo, &c., and a license for his line for a period of 21 years, subject to conditions for the proper maintenance of the line and such repairs as may be needed; the line, rolling stock, and plant, to become the property of the Corporation at the end of the 21 years.

Wednesbury.—The Town Council on Monday had a discussion *re* tramways. The Mayor said there was no doubt the tramways in that district were a great boon, and he considered it to be the duty of the authorities to do all they possibly could to prevent the stopping of the tramcars, and to give their best encouragement for improvements to be carried out. The electric traction adopted between Wednesbury, Walsall, Bloxwich, and Darlaston was very satisfactory, and he hoped the Handsworth and West Bromwich authorities would support the scheme, and adopt the same system in their respective districts. The overhead electric traction had been proved to be satisfactory, and preferable to the cable system.—Alderman Wilson Lloyd concurred.—The Mayor said whilst they were all desirous of the use of steam on the tramways being abandoned, they were most anxious that tramway traffic should not be stopped.

TELEGRAPH AND TELEPHONE NOTES.

Durham Telephones.—The County Council is of opinion that there should be telephone competition, but does not bind itself to support the New Mutual Syndicate.

Indian Telegraphs.—Mr. C. H. Reynolds, C.I.E., Director-General of Telegraphs in India, recently left Calcutta on a tour of inspection in East Bengal and Assam, whence he proceeds, according to *Indian Engineering*, to Simla, after inspecting some of the newly-constructed lines in the Punjab. A more thorough inspection of these lines is to be made by Mr. A. B. Larkins, Director of Construction. A committee is to determine the value of old telegraph stores dismantled from the field lines on the frontier.

Pacific Cable.—The opening up of China, through recent International developments, has led to the mooting of another proposal for a Pacific cable. It is suggested that a cable may be carried from Vancouver Island to some port in the Sandwich Islands or to Fiji, bifurcating thence to New Zealand and Hong-Kong. There is no doubt, says the *Standard*, that strong efforts will, in the present circumstances, be made in influential commercial quarters to improve both the steamship and cable communications with China.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	April 12th, 1898 ...	...
Cape Town-Mossamedes ...	„ 14th, 1898 ...	...
Maranham-Para	„ 17th, 1898 ...	...
Benguela-Mossamedes ...	„ 20th, 1898 ...	...
Kotonon-San Thomé ...	„ 27th, 1898 ...	...
Hong Kong-Manilla... ...	May 3rd, 1898 ...	...
San Thomé-Loanda... ...	„ 4th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1898 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Saigon-Bangkok	April 29th, 1898 ...	April 30th, 1898

Telegraphic Communication between Liverpool and the Continent.—Some correspondence has been passing between the Liverpool Chamber of Commerce and the General Post Office regarding telegraphic communication between Liverpool and the Continent. The following letter has been addressed by Mr. J. C. Lamb to the Chamber:—

"With reference to your letters of the 26th ult. and the 25th inst., and previous correspondence on the subject of telegraphic communication between Liverpool and the Continent, I beg leave to inform you that the proposal to use a new cable wire for the traffic between Liverpool and Hamburg was duly carried out, and this department has since been in communication with the German Administration in regard to the adoption of duplex-Hughes working between England and Germany. It has not been found practicable under existing circumstances to introduce duplex-Hughes working between Liverpool and Hamburg, but the experiments in this method of working on other circuits between England and Germany have proved so far successful as to afford ground for entertaining the hope that a similar result may ultimately be attained under the more difficult conditions applicable to the Liverpool-Hamburg circuit. I may add that the German Administration have intimated that they share the desire of this department to expedite the transmission of telegrams between Liverpool and Hamburg, and have expressed their readiness to substitute a copper for an iron wire on the inland section of the circuit in Germany if it is found that the working of the circuit would be improved thereby, and experiments will be made as to the effect of such an alteration as soon as certain new wires which are now under construction in Germany have been completed. With regard to the question of the transmission of telegrams from Liverpool to Bremen *viâ* Hamburg, instead of, as at present, *viâ* London, I have to state that the Liverpool-Hamburg circuit is at present fully occupied, and would be unable to carry additional traffic without delay. In any case the proposed alteration would not lead to any reduction in the number of transmissions, telegrams sent *viâ* London being only subject to two transmissions, viz., from Liverpool to London and from London to Bremen, while, if sent from Liverpool to Hamburg, they would have to be re-transmitted from the latter city to Bremen. Similar considerations apply to the suggested use of the route *viâ* Havre in preference to that *viâ* London for telegrams from Liverpool to Paris. It is feared that the suggestion that the former route should be tried experimentally for a certain time is not one to which it would be practicable to give effect. The question of the transmission of telegrams between Liverpool and France is, however, under consideration, and this department is in communication with the French Administration in the matter. I have to add that if certain experiments which will shortly be carried out yield satisfactory results, it is proposed to extend to provincial towns in England and France the telephonic service, which has hitherto been restricted to the two capitals, and in that case Liverpool would obtain the advantage of telephonic communication *viâ* London with Paris, and, where possible, with other French towns."

Telegraphists' Grievances.—A conference of M.Ps. and representatives of the Postal Telegraph Clerks' Association took place last week at the House of Commons. The matter will be brought up upon the discussion of the Postal Service estimates, and there will be supporters on both sides of the House.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—May 25th. The date for the receipt of tenders for the electric lighting plant at the railway station at Ghent (Gand-Sud) for the Belgian State Railway Authorities has been fixed for May 25th.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Blackburn.—May 17th. The Committee of St. George's Presbyterian Church invites tenders for the electric lighting of the Church. See our "Official Notices" this week for details.

Dublin.—May 23rd. The Corporation wants tenders for the supply of high tension feeders and low tension distributors laid and jointed complete on a solid system, not including road work, but including the connecting up of existing consumers to the new mains. Also for transformers (20 to 50 kw., about 700 kw. in all) with instruments and apparatus in sub-stations erected and fitted complete. Particulars at the office of the city engineer; or from Prof. Kennedy, 17, Victoria Street, S.W. See our "Official Notices" this week for particulars.

Edinburgh.—May 6th. The Corporation wants tenders for the wiring of the St. Leonard's police station. Particulars from the resident electrical engineer, 5, Dewar Place, and see our "Official Notices" last week.

France.—May 21st. Tenders are being invited by the French Post and Telegraph Authorities in Paris for the supply, in 10 lots, of 111 kilometres of paper-insulated electric cables. Particulars may be obtained from, and tenders to be sent to, Le Sous-Secretariat, d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Great Eastern Railway.—May 12th. The directors invite tenders for the supply of stores and materials. For particulars see our "Official Notices" last week. Forms of application from the secretary's office, Liverpool Street Terminus, E.C.

London.—May 17th. The Bethnal Green Board of Guardians invites tenders for the supply of plant, and installing the electric light at the new infirmary, Palestine Place. Plans, &c., to be obtained from the architects, Giles, Gough & Trollope, 28, Craven Street, Charing Cross, W.C. See our "Official Notices" April 22nd for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

West Ham.—May 10th. The Council wants tenders for certain electroliers, standards, &c., required for its public buildings. Mr. J. J. Steinitz, borough electrical engineer. See our "Official Notices" last week for particulars.

CLOSED.

Blackpool.—The Corporation has placed the order for 120 rectified current double carbon lamps, with special switches, &c., with the Gilbert Arc Lamp Company, Limited, of Chingford. This order has been given out after careful tests.

Coventry.—The following tenders were submitted for wiring the new police buildings for the electric light, in accordance with specification prepared by Mr. Ram:—Ellis & Ward, £230; Drake & Gorham, £316 10s.; Veritys, Limited, £197 10s; Dobson and Curtis Bros, Limited, £187 17s.; Coventry Gas Fitting, &c., Co, Limited, £170; W. Tasker & Sons, Limited, £161 13s. Messrs. Tasker's tender was accepted by the City Council on the Watch Committee's recommendation.

Derby.—Messrs. Read, Holliday & Co. have secured the contract for wiring the Fore Street Yard buildings at £197.

Hampstead.—The tenders accepted by the Hampstead Vestry for electric lighting extensions plant are given by a daily contemporary as follows:—Siemens Bros. & Co., Limited, two 350-kilowatt steam alternators, Willans-Siemens sets, £7,100; S. Z. de Ferranti, Limited, two "Ferranti" switchboard panels, £111; John Brown & Co., two induced draught boilers, £4,850; John Fraser and Son, feed water heater, steam and exhaust pipes, &c., £911; also two duplex compound steam feed pumps, £695; Siemens Bros. & Co., Limited, a 50-kilowatt exciter in place of existing 23-kilowatt alternator, £910; less allowance for existing alternator, to be removed by and belong to the contractors, £300 = £610.

Hull.—Messrs. A. Bannister & Co. have secured a contract from the Electric Lighting Committee for the supply of Hickleton coal at 12s. 2d. per ton. Messrs. King & Co. have received the order to wire the Sculcoates Lane station.

Liverpool.—The Generating Stations Committee accepted the tender of Messrs. Willans & Robinson, Limited, for the supply of two compound engines and dynamos, at the price of £6,530 each, and one triple expansion engine and dynamo, at the price of £6,939.

London.—The London County Council received the following tenders for the supply of nine parapet lamp columns and lanterns, and four standard columns and lanterns for the electric lighting of Waterloo Bridge:—McDowall, Steven & Co., £189 12s.; W. MacFarlane & Co., £192 15s.; Young & Co, £250. The tender of McDowall, Steven & Co. is recommended for acceptance.

Newington.—The contract for the erection of the electric light works in Penrose Street at £12,928 has been given out by the Vestry.

Wallasey.—Eleven tenders were submitted for the erection and completion of extension of engine and boiler house at the Council's electric supply station in Sea View Road, Liscard, and that of Messrs. Hughes & Stirling (£3,077) was accepted.

FORTHCOMING EVENTS.

1898.

Friday, May 6th, at 8 p.m.—The Institution of Junior Engineers at the Westminster Palace Hotel. Paper to be read and discussed:—"Evaporative Condensers and Independent Air-pumps for Same," by Mr. Harry Fraser (member).

Monday, May 9th, at 8 p.m.—Society of Arts. "Electric Traction." Cantor Lectures by Prof. Carus Wilson. Lecture II.:—Acceleration—Conditions under which a train is started—Method of drawing acceleration curves—Uniform and accepted acceleration—Example—The City and South London Railway—Control—Comparison of different methods—How to ensure a smooth start—The series-parallel controller—Example—The Buffalo and Niagara Falls Electric Railway—Effect of the slipping of the driving wheels.

The Northern Society of Electrical Engineers.—Palatine Hotel, Hunt's Bank, Manchester. Paper on "Electric Elevators," by Mr. W. C. C. Hawtayne.

Tuesday, May 10th, 7 p.m.—The Institution of Junior Engineers: Visit to Messrs. Brin's oxygen works, Horseferry Road, Westminster, to inspect in operation Dr. W. Hampson's self-intensive refrigerator of gases.

At 8 p.m.—General meeting of the Röntgen Society, at 11, Chandos Street, Cavendish Square, W. Prof. Silvanus P. Thompson, F.R.S., in the chair. Papers will be read on "Notes on the Description of a New Induction Coil in ELECTRICAL REVIEW, February 4th, 1898" (with demonstration), by Mr. A. Apps, M.I.E.E.; and "Some Notes on Contact Breakers," by Dr. J. Macintyre. Discussion to follow.

Thursday, May 12th.—Institution of Electrical Engineers. Meeting at the Society of Arts (subject to the discussion on Mr. Andrews's paper being concluded last night). Papers on "A Magnetic Balance for Workshop Test of Permeability," by Prof. J. A. Ewing, F.R.S., member; and "The Registration of Small Currents used for Electric Lighting and other Purposes," by A. H. Gibbings, member.

Friday, May 13th, at 5 p.m.—Physical Society. Paper on "Galvanometers," Part II. By Prof. W. E. Ayrton and Mr. T. Mather.

NOTES.

Water-Tube Boilers.—A series of interesting trials with the New Haythorn water-tube boiler was concluded on the Clyde last week. With a three months' certificate from the Board of Trade the Caledonian Steam Packet Company fitted the boilers on board their paddle steamer, *Meg Merrillies*. The engines were compounded by fixing a cylinder of 24 inches in place of one of 42 inches. The pressure of the two tubulous boilers is 200 lbs., reduced by reducing valves to 130 lbs. at the engines. Although, says the *Times*, there is always a possibility of defects developing in boilers of the type, the success of the trials so far is marked, a speed of 14 knots being obtained with half the consumption of coal necessary formerly to get a knot less.

Jubilee of the American Association for the Advancement of Science.—Writing in the *Scientific American*, Horace C. Hovey says:—

Fifty years ago the American Association for the Advancement of Science was organised for the purpose of promoting intercourse between scientific men throughout the Continent, encouraging systematic scientific research, and increasing the facilities for more thorough investigation, and enlarging the usefulness of scientific labours. These ends have been sought by periodical and migratory meetings, by publications, by wide correspondence, and perhaps, most happily of all means, by encouraging genial and familiar intercourse between scientists. The completion of the first half century of this noble work will be celebrated in an appropriate manner in the city of Boston, August 22nd—27th, 1898, and the preliminary announcements for the jubilee are already made. The meeting will be held in response to the invitation of the Governor of Massachusetts, the Mayor of Boston, and the numerous scientific and educational institutions that cluster about that centre of intellectual life and activity. This cordial invitation was accepted at the Detroit meeting of the Association. The Boston Local Committee, now organised, includes a most distinguished list of names, among which we note those of his Excellency Governor Wolcott, as the honorary president; 25 presidents of universities, colleges, and other institutions, together with others of distinction as honorary vice-presidents; 129 members at large; Dr. Thomas Dwight, Prof. Alpheus Hyatt, and Prof. E. C. Pickering as honorary secretaries, and Col. H. L. Higginson as honorary treasurer. The latter gentleman is also the chairman of a strong committee on finance. The chairman of the Reception Committee is Dr. J. R. Chadwick, that of the Committee on Invitations is Dr. Henry P. Bowditch, that of the Committee on Excursions is Gen. F. H. Appleton, and that of the Executive Committee is Prof. W. T. Sedgewick. The local secretary, to whom all correspondence should be addressed, is Prof. H. W. Tyler, of the Massachusetts Institute of Technology, Boston, Mass. The Boston scientific Jubilee promises to be one of the most important and interesting assemblies of the kind ever convened. Many foreign scientists of eminence will take part in the exercises, and make addresses. Foreign educational and scientific bodies will send delegates, thus giving the occasion an international character. A number of "affiliated societies," really the offspring of the A.A.A.S., will meet during the Association Week, including those for the study of geology, chemistry, botany, forestry, entomology, mathematics, engineering, &c. All general and sectional meetings will be held in the halls and rooms of the Institute of Technology and of the Boston Society of Natural History. One day will be spent as the guests of Harvard University, one day in the historic city of Salem, and excursions are planned for the White Mountains, Cape Cod, and other regions of interest. Members who have allowed their membership to lapse are requested to renew their connection with the Association. A thousand new members are called for, and every scientific man in America is appealed to in order to make this Fiftieth Anniversary of a great Association a marked event in the intellectual history of our continent. Anniversary cards will be sent, previous to the meeting, to all entitled to them, and a list of members in good standing will be printed for the opening day. Each of the nine sections will prepare a programme in advance, and notice of papers offered should be sent at an early date to the proper secretary. A special invitation is given to all surviving founders of the Association, that is, of those who shared in the meeting of 1848. The names and addresses of such should be sent at once to Prof. F. W. Putnam, Harvard University, Cambridge, Mass., so that they may enjoy the recognition to which they are entitled.

Cables in War Time.—There appear to be some people who have taken seriously a passing remark recently made by Prof. S. P. Thompson, hence the following letter in the *Pall Mall Gazette*:—

Sir,—In these stirring times of war, it has become more patent than ever how important it is for this country to be in uninterrupted telegraphic communication with its numerous colonies and dependencies. The mere possibility of the cables between Cuba and the outer world being cut naturally suggests what is in store for this country should it unfortunately be at war with a European power. I am surprised that a proposal made by Prof. Silvanus Thompson, in his recent lecture on "Telegraphy Across Space" at the Society of Arts, has not created the attention it deserves, coming, as it does, from so high an authority. The proposal was that if £10,000 were put at his disposal for the purpose, he would be able to erect the necessary apparatus for telegraphing without wires intervening between this country and any part of the globe. To be able to telegraph from London to Cape Town or to Calcutta, or to anywhere you like, without the possibility of the wires being cut, for the simple reason that under Prof. Thompson's plan there would be none to cut, is certainly "a consummation devoutly to be wished." I suggest that Prof. Thompson's plan be further examined, and if he can substantiate his claim—as from his great reputation there should be little doubt—the necessary funds should be put at his disposal by Government, in order to enable him to complete his experiments and to bring to perfection his plan of telegraphing across space.—Anglo-German.

Hedging.—We understand that Mr. Killingworth Hedges, C.E., has been elected a director of the Semzée Greyson Intensified Gas Light Syndicate, Limited.

Royal Institution.—The annual meeting of the members of the Royal Institution of Great Britain was held on Monday afternoon. Sixty-six new members were elected, and 63 lectures and 19 evening discourses were delivered in 1897. The following gentlemen were unanimously elected as officers for the ensuing year:—

President—The Duke of Northumberland, K.G.; Treasurer—Sir James Crichton-Browne; Secretary—Sir Frederick Bramwell, Bart.; Managers—Sir William Crookes, Sir Edward Frankland, The Right Hon. George Joachim Goschen, Donald William Charles Hood, Esq., David Edward Hughes, Esq., Alfred B. Kempe, Esq., Hugh Leonard, Esq., Sir William Huggins, Thomas John Maclagan, Esq., Ludwig Mond, Esq., Alexander Siemens, Esq., The Hon. Sir James Stirling, Sir Henry Thompson, Sir Richard Everard Webster, Sir William Henry White. Visitors—Sir Alexander Richardson Bennie, Sir James Blyth, Bart., Charles Vernon Boys, Esq., Edward Dent, Esq., James Edmunds, Esq., Maures Horner, Esq., Edward Kraftmeier, Esq., Sir Francis Laking, T. Lambert Mears, Esq., Lachlan Mackintosh Rate, Esq., John Callander Ross, Esq., William James Russell, Esq., Sir James Vaughan, James Wimshurst, Esq., Alfred Fernandez Yarrow, Esq.

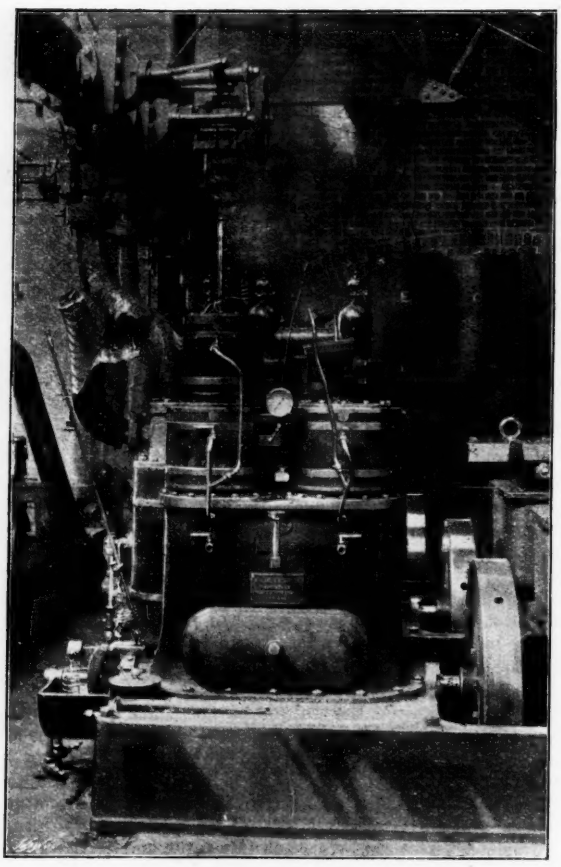
The Jandus Lamp.—The New York *Electrical Engineer* says that a very successful alternating enclosed arc lamp of the non-focusing type for circuits of from 7,000 to 16,000 alternations per minute, and voltages from 100 to 120, is being manufactured by the Jandus Electric Company, of Cleveland, Ohio. A resistance (or economy) coil is placed in the canopy of the lamp, easy of access and conveniently adjusted for the voltage of the arc. The efficiency is high, showing a loss of but 20 watts as the lamp is ordinarily adjusted, *i.e.*, 6 amperes on a 100 to 110-volt line. The lamp ordinarily consumes from 400 to 450 watts across the terminals, thus showing an average efficiency of 95 per cent. The carbons furnished with lamp consist of an equal number of $\frac{1}{8}$ inch core and $\frac{1}{16}$ inch core, each 8 inches long. By using the stub of the upper carbon for a lower in the succeeding run, but one fresh carbon per trim is necessary. One $\frac{1}{8}$ inch core and one solid carbon give good results. The life of one pair of carbons is about 80 hours.

The Welsbach New Gas Burner.—The Welsbach new gas burner has been introduced to the public with the usual blare of trumpets and the inevitable luncheon. At the refection which followed the demonstration at Niagara Hall on Monday, Sir J. Blundell Maple, M.P., gave the company a magnificent advertisement by announcing that his firm had abandoned electric lighting, and had substituted the Welsbach incandescent gas light, because it was cheaper, and produced greater warmth. We should have thought that even the shopkeeping aspect of the question would have had some regard for the truism that cheapness in first cost is not always compatible with economy. That the Welsbach gas light produces, at the expense of the atmosphere, greater warmth than an electric lamp no one will deny, and the Welsbach Company is welcome to the benefit of this argument. We are ourselves not above giving a gratuitous advertisement to the Welsbach Company, and it takes this form: When one is compelled, for one's sins or otherwise, to burn gas, then the Welsbach burner is probably the best in existence. Still, whatever improvements are made in this form of lamp, the great fact still remains that they burn the same old gas.

The Trolley in America.—From the *Electrical World* we learn that by a recent final decision given by the United States Circuit Court of Appeals in an action of the Thomson-Houston Electric Company *v.* the Union Railway Company, henceforth anyone can make or use the overhead trolley in America without paying royalties. The case referred to involved two claims of the Van Depoele Patent No. 450,443, over which there has been almost continuous litigation for several years. Although, according to our contemporary, the decision is merely on a motion for preliminary injunction to prevent the Union Railway Company from using the overhead trolley while the main case is awaiting decision, this opinion, being based on a point of law, applies to the main case, and renders the use of the trolley free from any fundamental patent claims, although there are, of course, plenty of details of construction still covered.

The War and the Malaga Electricity Works.—The chairman of the Malaga Electricity Company, Mr. R. C. Wyatt, of Moorgate Street, E.C., has been in communication with the Foreign Secretary, stating that this and another English company in Spain are in urgent need of coal, and if a supply cannot be obtained at once they must stop work, in which case the action of the idle Spanish workmen might be disastrous. The Foreign Secretary in his reply regrets that he cannot advise the companies in regard to their request for permission to charter two steamers from England to carry coal for the purposes of these works.

Mishap at Southampton Electricity Works.—On Thursday evening last week an accident occurred in the engine room at the Corporation Electricity Works at Southampton. The top of a G.G.S. Willans engine blew off, the cause being either water or something such as a broken ring or



pin getting into one of the steam ports. The damage is practically confined to the engine itself. The supply was maintained by the engines which were running in the new engine room. Very fortunately no one was injured. The photographic illustration will give some idea of the damage.

Appointments Vacant.—The Redditch District Council wants an engineer for the electricity works. See our "Official Notices" this week for particulars.

The Poplar Board of Works wants a resident electrical engineer to devise and carry out an electric lighting scheme. See our "Official Notices" to-day for particulars.

The Institution of Civil Engineers.—The Council have made the following awards for papers read and discussed before the Institution during the past session:—A Telford medal and premium to Mr. A. H. Preece, and a Telford premium to Mr. L. B. Atkinson. The presentation of these awards will take place at the inaugural meeting of next session.

The Telelectroscope.—Although we are not much impressed with the invention of the gentleman whose name wants ironing out, Herr Jan Szczepanik, we believe it is, there seems to be sufficient evidence that his suggested arrangement of oscillating mirrors has been anticipated by Messrs. Bastian & Parsons, who carried out experiments seven years ago. We have seen the correspondence and drawings referred to by these gentlemen in their letter, and, without going into the matter very closely, there seems to be *à priori* publication of Herr Szczepanik's idea of employing vibrating mirrors.

Holophane Globes.—The Committee on Science and the Arts of the Franklin Institute is reported to have recommended the award of the John Scott Legacy Medal and premium to Messrs. Blondel and Psaroudaki for their invention of holophane globes.

Falcon Works Engineering Society.—The annual dinner of the Falcon Works Engineering Society was held at Loughborough on Friday last. Mr. J. S. Raworth presided, and there were some 56 other guests present, including a large proportion of old members of the Society.

NEW COMPANIES REGISTERED.

Electric Laundry Company, Limited (57,077).—Registered April 22nd, with capital £10,000 in £1 shares, to carry on at Hampstead and elsewhere in the counties of London, Middlesex, Hertford, Surrey, Kent and Essex, the business of a laundry, as the same has been carried on by A. W. Armstrong, and to adopt a certain agreement. The subscribers (with one share each) are:—F. M. Marden, 3, Welbourne Road, Tottenham, clerk; F. Dawson, 41, Bookham Street, Hoxton, clerk; T. Dunsdon, 53, Shrubland Road, Walthamstow, clerk; W. T. Edmunds, 118, Beckenham Road, Beckenham, clerk; W. J. Hanbury, Iseldene, Beddington Corner, Mitcham, clerk; H. Elliott, 32, Chichester Road, Leytonstone, clerk; B. Templeman, 10, Haxlitt Road, Kensington, clerk. Table "A" mainly applies. Registered office, 16, Rosemont Road, Hampstead.

Electric Railway and Tramway Carriage Works, Limited (57,082).—Registered April 25th, with capital £150,000 in £5 shares, to acquire "The North of England Railway Carriage and Iron Works," West Strand Road, Preston, and to adopt a certain agreement and to carry on the business of tramway car builders, tramway, railway, omnibus and van proprietors, carriers, electricians, electrical and mechanical engineers, suppliers of electricity, machinists, &c. The subscribers (with one share each) are:—J. Kerr, 94, George Street, Edinburgh, contractor; G. Flett, 110, Cannon Street, E.C., contractor; B. Sykes, 33, Winckley Square, Preston, civil engineer; T. S. Turnbull, The Woodlands, St. Anne's-on-Sea, solicitor; A. H. Mayne, 13, Spring Gardens, Manchester, solicitor; F. Cox, Ruthven House, Marple, Cheshire, accountant; F. Crimes, 5, Merimer Street, Greenheys, Manchester, clerk. The number of directors is not to be less than four nor more than seven. The first are G. Flett, G. F. Fry, J. Kerr, R. H. Prestwick, and G. Richardson. Qualification, £500; remuneration, £600 per annum and a share in the profits divisible. Registered office, 13, Spring Gardens, Manchester.

British Continental Electricity Company, Limited (57,088).—Registered April 26th, with capital £20,000 in £10 shares (1,000 5½ per cent. cumulative preference), to carry on the business of electricians, mechanical, hydraulic, and general engineers, suppliers of electricity, electrical apparatus manufacturers, &c. The subscribers (with one share each) are:—W. A. Brodie, Villa Olivetti, Bordighera, electrical engineer; W. R. Cooper, 87, Upper Tulse Hill, S.W., electrical engineer; R. Alioth, 10, Albanalage, Basle, electrical engineer; C. J. Brodie, Fern Hill, Wootton, Isle of Wight, surgeon; F. C. Brodie, Sandown, Isle of Wight, physician; Mrs. S. C. Brodie, Sandown, Isle of Wight; S. Ward, 35, Gracechurch Street, E.C., solicitor. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification £1,000; remuneration not exceeding 20 guineas each per annum. Registered by Ward & Co., 85, Gracechurch Street, E.C.

Davey Paxman & Co., Limited (57,093).—Registered April 26th, with capital £250,000 in £10 shares, to adopt an agreement with J. N. and W. Paxman, for the acquisition of the business carried on as "Davey Paxman & Co.," at Colchester and elsewhere, and to carry on the business of mechanical electrical mining, water supply and general engineers, agricultural implement and tool makers, boiler makers, rolling stock and waggon builders, &c. The subscribers (with one share each) are:—J. N. Paxman, Colchester, engineer; W. Paxman, Colchester, engineer; A. P. Butcher, Colchester, manager; H. G. Plane, Colchester, manager; W. H. King, Colchester, secretary; J. J. Phillips, Colchester, foreman; T. W. Hall, Colchester, draughtsman. The number of directors is not to be less than two nor more than five; the first are J. N. Paxman (chairman), W. Paxman, and W. Marriage; qualification, £250; remuneration as the company may decide. Registered by Robinson and Stannard, 19, Eastcheap, E.C.

Macartney, McElroy & Co., Limited (57,101).—Registered April 26th, with capital £12,000 in £10 shares, to carry on the business of electrical engineers and contractors, consulting electrical engineers, and undertakers for the construction, supply and sale of electric plant, and to adopt an agreement with J. F. Macartney, J. A. McElroy, and B. W. Champion. The subscribers are: -J. F. Macartney, 41, Edgware Road, W., contractor, 90 shares; J. A. McElroy, 26, Cortland Street, New York, U.S.A., mechanical engineer, 90 shares; B. W. Champion, Queen's College, Cambridge, gentleman, 100 shares; H. J. Dawson, 15, Emmanuel Road, Cambridge, gentleman, one share; L. Cobbett, M.B., 2, Round Church Street, Cambridge, one share; W. R. Scott, 100, Great Western Road, Glasgow, engineer, one share; J. Speak, Kirton Grange, near Boston, England, gentleman, one share. The number of directors is not to be less than three nor more than seven; the first are the first three subscribers; qualification, £500. Registered by C. F. Martelli, 10, Staple Inn, E.C.

Electricity, Limited (57,121).—Registered April 27th, with capital £51,000 in £1 shares (1,000 founders'), to adopt an agreement with C. O'D. Barrow and C. H. Smith, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers are:—P. W. Davis, 61½, Fore Street, E.C., merchant, 250 shares; G. W. Grabham, M.D., Mathyns, Witham, Essex, 250 shares; C. G. Smith, 59, Hatton Garden, E.C., manager, one share; A. I. Grabham, 59, Farrington Road, S.E., engineer, one share; T. J. Stockall, 6, Clerkenwell Road, E.C., merchant, 250 shares; J. J. Stockall, 50, Ferme Park Road, N., merchant, 250 shares; H. Verden, 14, Great Winchester Street, E.C., solicitor, one share. The number of directors is not to be less than three nor more than seven. The first are the first five subscribers. Qualification, £250; remuneration, £200 each per annum (£300 for the chairman) and a percentage of the profits. Registered office, 6A, Austin Friars, E.C.

Frank Suter & Co., Limited (57,193).—Registered May 2nd, with capital £20,000 in £1 shares (4 000 5 per cent. cumulative preference), to adopt an agreement with F. W. Suter, H. E. H. Wyman, and T. White, and to carry on the business of electricians, electrical engineers, workers and dealers in electricity, motive power and light, founders, tool makers, boiler makers, millwrights, &c. The subscribers (with one share each) are:—F. W. Suter, 66, Berners Street, W., electrical engineer; H. E. H. Wyman, 66, Berners Street, W., electrical engineer; T. White, 66, Berners Street, W., electrical engineer; F. H. Jerson, 44, Downshire Hill, Hampstead, secretary; A. M. Bramall, 23, Leadenhall Street, E.C., solicitor; P. Holmes, Brookfield Cottage, Chigwell, Member Stock Exchange; G. S. Saunders, 23, Leadenhall Street, E.C., solicitor. The number of directors is not to be less than three nor more than five; the first are the first three subscribers; qualification £500. Registered by Bramall and Co., 23, Leadenhall Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Notting Hill Electric Lighting Company, Limited (25,921).—This company's return was filed on April 5th, when the whole capital of £100,000 in £10 shares (6,452 ordinary, 550 founders', and 2,998 ordinary preference) was taken up. The full amount has been called, and £100,000 has been paid.

Kensington and Knightsbridge Electric Lighting Company, Limited (26,193).—This company's return was filed on March 24th. The capital is £350,000 in £5 shares (50,000 ordinary, 10,000 first preference and 10,000 second preference); 15,000 ordinary, all the first preference, and 5,500 second preference have been taken up, and 5,000 ordinary are considered as paid; £5 per share has been called on the others, and £127,500 has been paid.

Rugby School Electric Lighting Company, Limited (39,309).—This company's annual return was filed on April 18th, when 90 shares were taken up out of a capital of £5,500 in £50 shares, and paid for in full.

Hove Electric Lighting Company, Limited (36,942).—This company's return was filed on March 29th, when the whole capital of £40,000 in £5 shares was taken up; £5 per share has been called and £39,970 has been paid, leaving £30 in arrears.

CITY NOTES.

Kingston-on-Thames Accounts.

We have not previously had an opportunity of referring to the very marked progress that was made by the Municipal Electricity Works at Kingston during the year 1897.

Mr. J. E. Edgcome, the borough electrical engineer, in his report to the Corporation points out that after the payment of all the works' costs for generation of electricity, maintenance and repair of machinery and mains, taxes, insurance, and all management expenses, there remains a balance of £867 19s. 9d. as compared to £301 3s. 1d. for 1896. This sum is sufficient to pay the interest for the year on the capital expended on the undertaking, leaving a balance of £43 12s. 1d. towards the repayment of principal. In other words, if the undertaking were the property of a company, sufficient profit on the works had been made during 1897 to pay interest at the rate of 3¼ per cent., and to leave a sum of £43 12s. 1d. in hand to be carried to the reserve fund.

We note that very considerable extensions are in hand, and if the present rate of progress is maintained, there is little reason why the close of the present year should not see the works approaching the profit-earning stage. The cost of production has been largely diminished, as will be observed from the subjoined figures.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£36,700*	—
Number of units sold	194,268	155,681
Number of lamps connected	9,200	6,825
Revenue from sale of current	£3,765	£2,892
Net revenue	£868	£301
Average price obtained per unit	4·85d.	4·64d.

Cost of production.	£		Per unit.	1896.
Coal	1,314		1·62d.	1·79d.
Oil, waste, water, and engine room stores	155		·19d.	·22d.
Salaries and wages at generating station	625		·77d.	·93d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	364	Works' cost 3·03d.	·45d.	·60d.
Rent, rates and taxes	100		·12d.	·12d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	454		·56d.	·58d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£3,012		3·71d.	4·24d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	3,765	0	0	4·85d.
Meter rents, &c.	104	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Sundry sales	60	0	0	—
Total	£3,929	0	0	4·85d.

* Includes xtensions now in hand.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·71d.; works' cost, 3·03d.

Elmore's German and Austro-Hungarian Metal Company.

The report of the directors of Elmore's German and Austro-Hungarian Metal Company, Limited, for the year 1897, to be submitted to the general meeting to be held in London on May 11th, states that the reduction of capital authorised by the meeting of July 21st last has been duly carried out, and that after writing off the amount brought forward, and the charges for the year, the amount standing to the cost of patents has been reduced to £84,252. The preference shares issued have been increased by the issue of £10,000 in July last. It will be remembered that this issue was made at the request of the meeting called for the reduction of capital. The loan to the "Metall" Company has been increased to £39,045, and mortgages to the extent of £40,000 upon the property at Schladern have been lodged with the trustees for the debenture holders. The option given to a syndicate in Hungary for the purchase of a license expired, and the directors did not see their way to renew it. They are now negotiating with one of the most important firms in Hungary, upon terms similar to those asked for last year, and, they believe, with a fair prospect of success. The debenture stock of the company, which now stands at £44,983, falls due for redemption on July 1st next. It is proposed to take power to issue £75,000 of debenture stock at 6 per cent., and to issue £60,000 during the present year, out of which the 8 per cent. stock will be repaid, and the balance expended in the purchase of copper, &c., at Schladern. With regard to the "Metall" Company's accounts, the directors, while regarding a profit of £3,203 as satisfactory, cannot but admit that the amount does not come up to their expectations. The value of the sales was 50 per cent. more than those of 1896, while the trading profit was £333 less. The decrease in the profit was due to the Government ordering a very much larger quantity than the directors were informed they would of tubes at the base, or lowest price. The directors demurred to this, and as a new regulation came

into force, which gave the company power to cancel the contract, it was arranged that it should be cancelled. This was done, and, at the request of the Admiralty, the company tendered again, but at greatly enhanced prices. The directors are glad to report that the tender has been accepted, and that the company has been allotted nearly the whole of the new contract, only small tubes up to 1⅝ inches in diameter going elsewhere. Notwithstanding the increase in the sales during the past year, the company were unable to accept even a moiety of the orders offered, and therefore gave orders for new plant, sufficient to double the output of the year 1897. A portion of this new plant is already at work. The sales for the quarter ended March 31st show an increase of 77 per cent. over those for the same period last year. The directors have also purchased additional land available for further extensions, upon a portion of which they have erected workmen's dwellings. The directors are pleased to report that the process now works smoothly, and that the new plant being erected contains improvements which reduce materially the cost of repairs and maintenance. With regard to the profit shown, the directors would beg to remind the shareholders that the sum of £5,749 has been deducted from revenue by way of depreciation during the past three years. In view of the cash requirements of the "Metall" Company for the new plant and copper at Schladern, the directors regret they cannot recommend the payment of a dividend out of the profit, and have carried forward the amount to the credit of the accounts for this year.

Calcutta Electric Supply Corporation, Limited.

The first annual general meeting was held on Friday last, at Cannon Street Hotel, Colonel A. J. Filgate presiding.

In moving the adoption of the report, the Chairman regretted that greater progress had not been made with the works of the company, but they had had many matters to deal with which had occasioned delay. The question of what mains should be laid underground and what wires fixed overhead had involved protracted negotiations with the Government of Bengal, the Telegraph Department, and the municipality of Calcutta, but in February last the Government engineer approved a scheme which enabled the directors to give the necessary orders to the contractors to carry out the works. According to a telegram received a day or two ago, the Government authorities and the Calcutta municipality had agreed that, on the expiration of the period of 21 years for which the company's concession had been granted, it should be renewed for a further like period unless the undertaking was purchased by the municipality. On the whole, he thought the affairs of the company were now in a satisfactory state, and that the whole of the mains at present contemplated would be ready by the time the generating station was in a position to supply current. From what he knew of Calcutta, he believed they were likely to have a very successful undertaking.

Mr. E. Boulnois, M.P., seconded the motion, which was adopted.

City of Birmingham Tramways Company, Limited.

Mr James Ross presided at the annual meeting of the company, held at Birmingham last Friday, and pointed out that the financial results had been satisfactory, in spite of the fact that their endeavours to improve the system had been frustrated by the Committee of Public Works and the Council. The chairman then detailed the circumstances, and quoted from letters to show that the Council had accepted the terms of the company to construct an overhead wire system with not more than 10 miles of conduit. Subsequently the Council withdrew their consent to permit an overhead system to be erected. The chairman, in conclusion, mentioned that the board had appointed as managing director Mr. G. C. Cuningham, who had had considerable tramway experience in Canada. Under the extended powers arranged between the Council and the company some time ago a new system was to be installed, and the public were looking for splendid concessions, but all this had been put on one side by a sudden and unexpected change of front on the part of the Public Works Committee.

The report was then adopted, and a dividend at the rate of 5 per cent. declared on the ordinary shares.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.

The gross receipts for the half-year ended December 31st, 1897, including Government subsidies, amounted to £275,142 7s. 2d., against £325,405 12s. 6d. for the corresponding period of 1896. This decrease is due to the reductions of tariff brought into force during the past year and the falling off of Australasian traffic. The working and other expenses, including £30,956 8s. 6d. for cost of repairs to cables and expenses of ships, absorb £102,844 13s. 10d., against £106,270 9s. 7d. for the corresponding period of 1896, leaving a balance of £172,297 13s. 4d. From this is deducted £4,559 2s. for income-tax, £32,606 13s. 9d. for interest on debentures, debenture stock, and contribution to sinking fund, &c., leaving as the net profit for the half-year £135,131 17s. 7d., which, with £34,812 16s. 3d. brought forward from the previous half-year, shows an available balance of £169,944 13s. 10d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on the 12th prox., making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1897. The balance of £57,444 13s. 10d. has been transferred to the general reserve fund. The report states:—"The policy of strengthening the service by making judicious renewals from time to time in the weakest sections of the cables has been continued during the half-year under review, and the cost of the renewals carried out during that period has been charged against the general reserve fund. The contract made with the Spanish Government for extending the company's system from Manila to the islands of Panay, Negros and Cebu was successfully completed, and the new cables opened for traffic in November last. Since the close of the half-year a further contract has been entered into with the Spanish Government for improving telegraphic communication with the Philippines by extending the Hong Kong cable, which was originally landed at Cape Bolinao (Luzon), direct to Manila. The contract was completed last month, and the station at Bolinao removed to Manila. In accordance with the provisions of the trust deed dated May 10th, 1879, 451 of the company's 5 per cent. Australian Government subsidy debentures, amounting to £45,100, were drawn by lot on the 4th inst., for payment at par on July 1st."

The West Coast of America Telegraph Company, Limited.

The report of the directors for the year ended December 31st, 1897, to be presented at the first ordinary general meeting on May 10th, 1898, states that the gross income for the year 1897, as shown in the annexed revenue account, was £25,773. The continued depressed state of the nitrate industry, and of trade generally on the West Coast of South America, has had an adverse effect upon the traffic receipts; but the income of the company was sufficient to provide for the working expenses (£19,476 0s. 2d.) and the interest on the 4 per cent. debentures, leaving a balance of £296 19s. 10d. to be carried forward. The company's cables, landlines, and the repairing steamer have been maintained in a state of efficiency. The directors regret to report the decease of their esteemed colleague, Lord Sackville A. Cecil, on January 29th last, to replace whom, Sir Albert J. Leppoc Cappel, K.C.I.E., has been elected by the board.

The Spiral Globe, Limited.

As foreshadowed in our last issue, the prospectus of this company is now before the public, the capital offered being 75,000 shares of £1 each, out of a total capital of £150,000.

The vendor, Mr. S. B. Apostoloff, of 5, Fenchurch Street, London, has fixed the price at which he is willing to sell the whole of the patents and patent rights to the company, at £10,000 cash, £25,000 in fully paid shares, and £30,000 in cash or shares at the option of the directors. The company has in addition to pay a further sum of £25,000 in cash to the vendor on the sale or commercial working of the various foreign patents if as and when sold, a certain sum being allocated to each patent.

The spiral globe is a simple and pretty addition to an ordinary incandescent lamp, and apparently acts as a collector and diffuser of the light rays. It has, however, the disadvantages of acting as a dust collector, and of being fragile. Mr. F. J. Down estimates the sales at the rate of 2,000,000 per annum, and the profits on these sales at £26,000 per annum, increasing with a natural increase of sales to £35,000 per annum in subsequent years. We cannot follow this enthusiast in his appreciation of the invention, as shown by his report, but we think the spiral globe a pretty addition to the lamps ordinarily sold, and were the vendor content with pence, instead of the pounds named, there might be some future for the company.

London Platino-Brazilian Telegraph Company, Limited.—A meeting of this company was held at the offices of the company at London Wall yesterday, but we were informed that the proceedings were private.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 29th, 1898, were £2,694 4s. 7d.; corresponding period 1897, £2,292 0s. 3d.; decrease, £402 4s. 4d.

The City and South London Railway Company.—The receipts for the week ending May 1st, 1898, were £988; week ending May 2nd, 1897, £934; increase, £54; total receipts for half-year, 1898, £18,757; corresponding period, 1897, £18,546; increase, £211.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 30th, 1898, £130 8s. 10d.; total receipts to April 30th, 1898, £1,951 11s.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, April 29th, 1898, were £476 15s. 8d; corresponding week last year, £537 18s. 7d.: decrease, £61 2s. 11d.; passengers carried, 77,851; corresponding week last year, 81,812; aggregate to date, £7,368 17s. 1d; aggregate to date last year, £7,655 3s. 10d.; decrease to date, £286 6s. 9d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 1st, 1898, amounted to £1,451; corresponding week last year, £1,276; increase, £175.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending May 2nd, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,362.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, April 27th.	Closing Quotation, May 4th.	Business done during week ended May 4th, 1898. Highest.	Lowest
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 62	60 63	60	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	109 110	110½ 111½	111½	109½
3,038,020£	Do. do. Defd.	Stock	...	...	...	12½ 13	14 - 14½	14 9/16	12¾
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	15⅝ 16¼	15⅝ 16¼	15 15/16	15⅝
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	...	...	112 116	112 - 116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	...	155 —1 5	160 —170	...	...
918,297£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106	103 —105	104½	104
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6 — 7	6 — 7	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14 — 15	14 — 15	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10 - 10½	10½ 11	10 9/16	10
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	93 —101	98 —101	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	16⅝ 17¼	17 7½	17⅞	16⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18 19	8 - 19	18⅞	18½
89,900	Do 5 % Debs., repay. August, 1899	100	5 %	5%	...	.00 1 3	100 1 3	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	125 129	127 —130 xd	123½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7½	7 %	17⅜ 18¼	18 — 18½	18¼	17⅞
25,200£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,849, 3,976 to 4,326	100	5 %	5%	5 %	99 103	100 —104	...	...
100,500£	Do. do. Bearer, 1,850—3,975 and 4,327—6,400	100	5 %	5%	...	100 103	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4%	4 %	127 - 130	127 - 130	...	...
35,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	100 103	100 —104	...	...
46,500	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 - 103	101 —1 4	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 - 105	102 - 105	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	.07 110 %	1 5 —108 xd	108½	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅛%	4½%	...	11¼ 11⅜	11¼ 11⅜xd	11⅜	11 7/16
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	16⅜ 17¼	16⅜ 17¼xd	17	16⅜
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	10 %	29 - 30	28½ - 29½	29⅜	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5%	5 %	100 —103	100 - 1 3	101	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	97 —102	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	50 — 53	52	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 —109	106 - 109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5⅛%	5⅛%	6 %	5 - 5½	5½ - 5⅝	5 11/16	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 - 17	15 - 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 - 17	15 - 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5½	5½ 5⅝	5 9/16	5 7/16
1,129,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	100 -105	100 -105	102¼	102¼
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝ — ¾	⅝ ¾ xd	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 108	105 - 108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 9	8 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 141	136 141	...	...
58,000	United River Plate Teleph., Ltd.	5	4 %	5 %	...	4 - 4½	4 - 4½	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	105 - 108	105 - 08	106	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	3½ 4½	3½ 4½	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 102	99 102	...	...
64,269	Western and Brazilian Teleg., Ltd.	15	2 %	2 %	...	11½ 12	11½ 12	11 13/16	11½
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	7½ 8	7½ 8	7⅞	...
33,129	Do. do. do. Def. Ord.	7½	1 %	nil	...	4¼ - 4⅝	4¼ - 4⅝	4 7/16	...
389,521	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	106 —109	105 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	1 %	¼ %	⅛ — ¼	⅛ — ¼	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7 — 7½	7¼ — 7⅝	7½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000£	Do. do 5 % Debs. No. 1 to 1,600	100	5 %	5 %	5 %	105 —108	105 —108	106½	106½
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13 — 14	13 — 14	13⅜	13½
20,000	Do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 16,277	5	5 %	5 %	6 %	9½ — 10½	9½ — 10½	10½	9 13/16
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—90,000	10	5 %	7 %	10 %	25½ - 26½	26 — 27	26⅞	26⅛
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	10	...	...	...	17½— 18½	18 — 19	18⅜	18
40,000	Do. do. 5 % Cum. Pref., 1 to 40,000	10	5 %	5 %	5 %	17½— 18½	17½ — 18½	18	17⅜
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	nil	14 — 15	14 — 15	14⅜	14¼
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 pd.	10	...	...	...	8½— 9	8½— 9	...	...
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
17,400	Edmundsons Elec. Corp., Ld., ord. shares 1—17,400 £4 pd.	5	...	...	...	4 — 4½	4 — 4½	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5			4 %	10 — 11	10 — 11	...	...
10,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	11 — 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, Ltd., 101 to 62,500	10	4 %	5 %	6 %	17½— 18½	18½— 19½	18 15/16	18⅜
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	117 —121	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19 — 20	19 — 20	20	19 9/16
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½%	17½— 18½	17½— 18½	18¼	17⅝
20,000	Do. do. 7 % Pref., 20,881 to 40,880	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½— 2⅝	2½— 2⅝	2 11/16	2 9/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000	5	7 %	9 %	12 %	16⅞— 17⅛	17 — 18	17⅝	17⅛

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation April 27th.	Closing Quotation, May 4th.	Business done during week ended May 4th, 1898. Highest.	Lowest
30,000	British Electric Traction	10	...	...	...	15½— 16½	15½— 16½	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all paid)	10	...	...	...	7½— 8½	7½— 8½	...	...
90,000	Brush Elecl. Engng. Co., Ord., 1 to 90,000... ...	3	2½%	*nil*	*nil*	1⅛— 1⅜	1⅛— 1⅜	1⅛	...
90,000	Do. do. Non-cum. 5 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2⅛— 2⅜	2¼— 2½	2 3/16	...
125,000£	Do. do. 4½ % Perp. Deb. Stock...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ..	Stock	...	...	...	102 —105	102 —105	103	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10⅝	10 7/16
129,179	Do. do. do. £6 paid	10	...	...	...	6½— 6¾	6 — 6½	...	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½— 1⅝	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅛— 4¼	4⅛— 4¼	...	...
630,000£	City and South London Railway	Stock	1 1/16%	1 1/16%	1⅞%	67 — 69	67 — 70	70	69
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2 — 2⅛	2 — 2⅛	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5⅛%	...	2¼ — 2⅜	2¼— 2⅜	2⅛	2⅜
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5⅛%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	....	2⅝ — 2⅞	2⅝— 2⅞	2¾	2 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 .	2	7 %	7 %	...	3⅛— 3⅜	3⅛— 3⅜	3⅜	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	⅛— ¼	⅛— ¼	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ..	2	...	...	...	⅛— ⅜	⅛— ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	21½ — 22½	21½— 22½	22¼	22⅜
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	19½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21¾	21¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	102	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½%	2½%	3½%	10 1/16 — 10 3/16	10⅝— 10¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16½	15½— 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35 — 38	35 — 38	37	35½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000£	Waterloo and City Railway, Ord. Stock	100	...	...	...	133 —136	133 —136	133	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* **Birmingham Electric Supply Company, Ordinary £5 (fully paid)** 10⅝.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16—17; **1st Preference Cumulative 5 %, £5 (fully paid),** 8— 8¼. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10 %.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 3½—4.

* T. Parker, Ltd., £10 (fully paid), 15¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 4 per cent. (April 7th, 1898).

THE STEAM TURBINE ENGINE AND ITS APPLICATIONS.*

By JNO. D. BAILIE.

During the 13 or 14 years which have elapsed since the introduction of the compound steam turbine, many modifications and changes have been made both in the engine itself and in its auxiliary parts. A *résumé* of the various forms through which this engine has passed would occupy more time than is at disposal; it may, however, be said that the two most prominent types—judging from the standpoint of practical and commercial success—have been the "Twin Parallel Flow" and the "Radial Flow" turbines, and as many of both of these are still at work in central electricity supply stations and elsewhere, it may be well to begin the paper by a brief description of their leading features.

In the twin parallel flow turbine the motor spindle is fitted with two sets of rings of curved blades, one complete set in each half of the machine, and on the inner periphery of the cylinder are corresponding rings of blades of opposite curvature between which those on the spindle rotate. The blades on the inside of the cylinder are guides, their function being to direct the steam on to those on the spindle. Steam is admitted at the centre of the turbine case, all round the shaft, and flows simultaneously right and left through each series of rings of blades to the ends of the cylinder, thence to the common exhaust—the rotation being caused by the impact of the steam on the spindle blades. The flow of steam being equal in each direction, end pressure and excessive wear on the bearing collars are avoided.

The bearings are of somewhat unusual construction. Surrounding the bearing sleeve, or bush, are two sets of steel washers, which are in turn encircled by a steel liner—the latter being a free fit in the bearing seat. Each washer is about $\frac{1}{16}$th inch thick. They are of two diameters, and are arranged alternately small and large, the smaller being a close fit on the bush and about $\frac{1}{32}$nd inch clear of the liner, and the larger a close fit in the liner and about $\frac{1}{32}$nd inch clear of the bush. They are held tightly together by a strong spiral spring, and any lateral movement due to imperfect balance makes them slide mutually against one another, thus permitting the shaft to find its own centre of gyration, relieving the pressure on the bearings, and damping vibration.

The lubrication of the bearings is automatic and continuous by means of a fan and a screw fixed on the turbine shaft. The suction of the fan acting on the free surface of the oil in the stand-pipe draws it up to the screw, which in turn forces it through the adjacent bearing, and also through a feed-pipe to the other bearings, from whence it flows back through a return pipe to a reservior, to be again raised by the fan, and the process repeated.

The speed is controlled by a rather nice arrangement. A leather diaphragm is mechanically connected to the throttle valve by means of a rod and crank, and so operates it, that as the diaphragm distends the throttle valve opens to steam, and *vice versâ*. An airway leads from the diaphragm to the inlet of the fan, so that when the turbine is working, the suction of the fan tends to close the diaphragm against the tension of a spring. The action is as follows:—When the speed becomes too high, the suction of the fan increases, partially closes the diaphragm, and so reduces the admission of steam; conversely, when the speed falls below the normal, the suction of the fan decreases, the diaphragm extends, and opens the throttle valve to admit more steam. This combination in itself exerts very fair control, but is scarcely sensitive enough for electrical work; it is therefore supplemented by an electrical regulator. On the magnet yoke is a vertical spindle, on which are delicately pivoted a small iron bar or needle, and a tuning fork shaped arrangement with flat heels. An air-pipe leads thence to the leathern diaphragm. When the machine is excited, the magnet yoke attracts the needle, and a spiral spring makes it tend to resist the attraction. The spring is so adjusted, that the greater the magnetic pull, the more is the mouth of the air-pipe closed by the hind heel of the tuning fork. When, therefore, the speed of the machine, and consequently the magnetic pull, get below the normal, the heel falls back and opens up the mouth of the air-pipe, the inrush of air tends to neutralise the suction of the fan, and allows the diaphragm to extend, thus opening the throttle valve to admit more steam. On the other hand, when the speed and magnetic attraction get above the normal, the heel closes the air-pipe inlet, allows the fan to contract the diaphragm, and so reduces the admission of steam.

The radial flow turbine differs from the foregoing in that, instead

* Abstract of a paper read before the Yorkshire College Engineering Society, February 14th, 1898.

of the steam flowing in a direction parallel to the axis, it flows radially outwards. In this type there are several discs fixed on the shaft, and revolving with it, from the front faces of which the blades or vanes project in the form of a series of concentric rings. In one complete turbine motor there would be, perhaps, six of these discs of equal diameters, also a disc of considerably greater diameter fitted on both its faces with rings of blades of larger dimensions than those on the other discs; this large one may be termed the low pressure disc. Between the moving discs are stationary discs, attached to the case, on which the rings of guide vanes are so arranged as to alternate with the rings of moving blades. Steam enters at one end of the cylinder, inside the smallest ring of blades on the first disc, passes through the successive rings to the circumference, thence between the back of the rotating disc, and of the next stationary disc, to the inmost of the next series of rings. This is repeated until the centre of the low pressure disc is reached, when the steam flows through the blades on both sides of the disc simultaneously, and thence to the exhaust.

The steam turbine as now made is somewhat similar to the one first described, in that it is of the parallel or axial flow type.

The turbine shaft is encircled concentrically by a series of "drums" of several diameters, round the outer circumference of which the sets of rings of moving or rotator blades are fitted. The interior of the turbine case is correspondingly stepped, and is fitted with rings of guide blades of similar but opposite obliquity to those on the spindle. The rings of guide blades alternate with the rings of rotator blades, so that when the machine is at rest the spaces between the blades form a series of zig-zag passages or channels. The diameters of the drums, the dimensions of the blades, and the steam passages, are graduated to suit the increase in the volume of the steam as it expands towards the low pressure end. Each ring of guide blades, together with its corresponding ring of rotator blades, may be regarded as a turbine complete in itself, the steam turbine engine therefore consists of a considerable number of small turbines, at each of which expansion of the steam takes place. Steam is admitted through a double-beat valve, and entering the cylinder all round the spindle, passes through the first ring of guide blades on to the first ring of rotator blades, then through the second ring of guide blades to the second ring of rotator blades—and so on, losing pressure at each step, until it has passed the last ring of rotator blades, when it exhausts into the condenser or atmosphere, as the case may be.

No effective work is done by the barrels; they are merely revolving baffle pistons, or "dummies," to balance the end thrust due to the pressure of the steam on the turbine blades. They are stepped similarly to the bladed barrels, with which those of corresponding diameters are connected by channels in the casting in order to equalise the pressure. The adjustable thrust bearing takes up any slight endlong pressure which may not be neutralised by the dummies. This thrust bearing differs from the usual pattern only in that the grooved bush is split longitudinally into halves, with separate adjustment for taking up wear. The thrust bearing is adjusted by a screw at the end keep of the engine. The end play can be tried when the engine is running slow by slackening the nuts holding down the keep, and inserting a lever between the keep and the cylinder; it should not be more than, say, $\frac{1}{100}$th inch. If the bottom half of the thrust is worn, a thin liner may be put in at the back.

The bearings are of the tubular type, and consist of a phosphor bronze, or gun-metal bush in which the shaft rotates; round this bush are slipped three concentric steel tubes, each fitting loosely over the one inside it, the outermost being a free fit in the bearing seat. The bush has grooves cut on its inner periphery, and the tubes are perforated to allow the free passage of the oil. When the machine is working the clearance between each tube and its neighbour is charged with a film of oil, with a result that, while the shaft retains a small amount of freedom, the viscosity of the oil acts as a damper to prevent oscillation. The circulation of the oil is continuous and automatic by means of a pump driven by an eccentric and worm gear from the turbine shaft, the supply of oil is therefore proportionate to the speed. In some machines the oil is continuously fed into the bearings under a head of some 6 or 8 inches, from cisterns immediately above them; it then drains into a receiving chamber, from which it is again pumped to the various cisterns. In other machines the keeps are sealed, and the oil is forced through the bearings under a pressure of from 5 to 10 lbs. per square inch. The cisterns are all connected by pipes, so that the one pump maintains the circulation.

When the turbines are to be used in tropical climates, or in exceptionally hot places, oil coolers are frequently fitted. These may be built into the bed-plates, and consist merely of a cast-iron shell containing a spiral copper tube, through which the oil is passed on its way to the reservoir, the cooling being effected by a water circulation.

The engine is coupled to the fan, dynamo, pump, or other machine to be driven, by means of a square bored sliding sleeve, fitting loosely over the squared ends of the respective shafts. The exterior of this sleeve carries the worm which drives the worm-wheel, which in turn, by means of an eccentric and connecting rod, transmits the motion to the oil-pump plunger.

This worm gear also plays an important part in the governing arrangements; but as the method adopted for controlling the turbine depends upon the nature of its work, it will be dealt with later on.

When very large powers are required, it is sometimes found advantageous to use more than one cylinder, and to pass the steam through them in the usual sequence.

Turbines are designed for working either condensing or high pressure, and they lend themselves readily to either condition. At some places they are required to work part of the time on the condenser, and part on the atmosphere; when this is so, they are bladed for condensing, but fitted with a bye-pass and valve, with which the excess blades may be cut out when working on the atmosphere. The relative saving effected by condensing is more than with reciprocating engines, for the steam may be expanded down to 1 lb. absolute, or even lower, without any material increase of frictional resistance, and a very high ratio of expansion is therefore practicable; indeed, it is usual to blade a condensing turbine for the terminal pressure of 1½ lb. absolute per square inch. It is evident, therefore, that where condensing is feasible it should be resorted to, and the condenser adopted should be one giving a high vacuum. Frequently the engine is fitted with its own condenser; the shell containing the tubes forming part of the bed-plate, and the air and circulating pumps being driven from the worm on the turbine shaft by a rocking beam.

The turbine is best adapted for speeds of not less than 2,000 revolutions per minute, and they are usually designed to run at from 3,000 to 6,000 revolutions; when the speed of the machine to be driven is considerably below 2,000, gearing or belts may be interposed. At first sight, gearing would seem to be unsuitable for these speeds, both as regards durability, efficiency, and quietness of running, but very fair results have been obtained with double helical spur gear made of steel. This type of gear is also used when it is desired to adjust relatively higher speeds, and ratios of as high as 8 to 1 have been successfully negotiated. In a 16-kilowatt turbo-dynamo built some time ago, the turbine ran at 25,000 revolutions, and the dynamo at 4,000 revolutions, a ratio of 6¼ to 1. A 150-kilowatt turbo-alternator at the Newcastle and District Company's station has a ratio of 2 to 1, the turbine running at 9,400 revolutions and the alternator at 4,700 revolutions. Hitherto, reducing gear has not been employed when the machines have been built for power work, but at the present time a launch is being engined with a turbine gearing on to two propeller shafts. The use of reducing gear enables the turbines to be run at a very high speed, and so greatly decreases the weight per horse-power, but at present the writer much prefers direct driving, especially when the load is liable to sudden variation.

The Steam Turbo-Dynamo.

When the turbine engine was first introduced, electrical engineers recognised its marked suitability for driving dynamos, and for several years this was the only use to which it was put. The first turbo-dynamo built was a small one, giving only 4½ kilowatts, and running at 18,000 revolutions per minute; nowadays, for central electricity supply stations, plants having capacities of from 350 to 1,000 kilowatts are not uncommon. One of the large London companies alone has no fewer than 13 of these turbine plants, each giving 350 kilowatts, four each giving 500 kilowatts, and others equally large are being built for them at the present time. They are also used in the supply stations of Newcastle, Cambridge, Woking, Portsmouth, Scarborough, Madeira, Woolwich, Blackpool, &c., so that their fitness for this class of work would seem to be proved.

Turbo-dynamos are also being largely and increasingly used for power work at collieries, for driving iron works and other places where heavy and sudden changes of load are met with, as well as for electric traction, and they do their work well. Indeed, this is a direction in which, in the opinion of the writer—and in the opinions of the users also—they score heavily over reciprocating engines. He would emphasise this by adding that, so far as he is aware, in no single instance where users have installed turbines for power work have they, when extending, reverted to reciprocating plant. The principle of the engine eminently fits it for dealing with extremely variable loads without detriment, and the governor, which being a special feature will be described at length later on, exercises such perfect control that practically no attention is required.

The steam turbine dynamo ordinarily comprises a multiple expansion steam turbine coupled direct on the same bed-plate to a high speed dynamo, by means of a square bored sleeve. The dynamo bearings are similar to those of the engine, and are connected with them by pipes, so that the one oil pump provides the circulation for all.

The electrical governor which controls the speed of the machine is very quick and reliable in its action.

A centrifugal "safety" governor is usually fitted to large machines, to come into action only in the event of accident. It derives its motion from the worm on the turbine shaft through the worm wheel and the bevel gear, and actuates a valve in the relay by means of a rod and clutch. It is set so as just not to blow off when the machine is at full speed.

The hand lever above the relay is merely for the purpose of lifting the main valve at starting, or for admitting steam to warm through. A similar lever embraces the collar of the centrifugal governor spindle. Either of these levers might be used in an emergency for shutting off steam from the engine; the long lever will answer the same purpose, for if moved either to its top or bottom position, the main valve closes.

Turbo-alternators run perfectly in parallel, either with each other or with any of the leading slow speed machines.

These turbo-electric generators would seem to compare very favourably with other types as regards economy in steam consumption, especially when working condensing. A 100-kilowatt turbo-dynamo supplied to one of the Lancashire corporations gave a consumption of 29·1 lbs. of steam per electrical horse-power at full load, and 22·3 lbs. at half load. The steam pressure at the machine was ·02 lbs., and the and the vacuum was 26¾ inches. A 50-kilowatt plant, supplied to the same corporation, used 20·9 lbs. per electrical horse-power at full load, the steam pressure being 90 lbs. and the vacuum 28¾ inches.

A 200-kilowatt plant supplied to a large ironworks near Chester gave, with a boiler pressure of 100 lbs. per square inch and a vacuum of 25 inches, a consumption of 19·51 lbs. per electrical horse-power at full load, and 20·9 lbs. at half load, a rise from full load to half load of only 7½ per cent.

A 150-kilowatt turbo-alternator supplied to a central electricity supply company gave the following results:—The steam pressure at the machine was 70 lbs. per square inch, and the vacuum was 26½ to

26¾ inches; the steam consumption at full load was 17·28 lbs. per electrical horse-power, at half load 20 lbs., and at one-fourth load 22·01 lbs.

In all the above, the consumptions are to be taken as per electrical horse-power-hour.

The machines quoted are not necessarily the most efficient that have been built; the writer has chosen them because he has been connected with them to some extent, three out of the four having passed through his hands; he thinks, therefore, that they may be taken as fair examples of the efficiency of condensing type steam turbine plants of medium size.

The writer concludes by saying that the advantages claimed for the turbine are:—Simplicity, compactness, lightness, portability, absence of vibration, low cost of foundations, ease and cheapness of repairs, long life of bearings, automatic lubrication, steady governing, absence of cylinder lubrication, economy in oil, indifference to priming, low all round steam consumption, absence of cylinder condensation, general satisfactory working, and saving in attendance.

COMMERCIAL FORMS OF ELECTRICAL RESISTANCES FOR LIGHTING AND POWER PURPOSES.*

By Ll. B. ATKINSON.

(*Concluded from page* 592.)

Resistances for Regulating Dynamo and Motor Shunts.

Almost any of the forms are suitable for this purpose. As to capacity, the maximum amount of power to be dissipated is reached when the resistance is equal to the resistance of the shunt, and when the current comes down to half its original value.

Resistances working by compression, and therefore giving a perfectly steady graduation between maximum and minimum, have the advantage of allowing the E.M.F. to be regulated very exactly, an advantage where dynamos are being run in parallel.

Arc Lamp Resistances.

These form an important class, as very large numbers of them are used.

The usual form consists of a porcelain cylinder, having a spiral upon it, in which is wound a German silver wire. The resistance is regulated by a movable clamp, placing more or less of the wires in circuit.

Three forms of arc lamp resistances were designed by the writer some years ago, in each of which the base is an iron cylinder covered with asbestos, on which the resistance is wound. All these forms of resistance have the disadvantage that as the wire is heated and cooled it is subject to very considerable strains, and the wires are frequently fractured.

In that form of arc lamp resistance in which "Relugite" is utilised as the resisting material, and the resistance is adjusted, as required, by tightening or slackening the end on the top.

An important advantage possessed by this latter form of resistance is that as the coefficient of temperature variation is negative, the resistance is higher when first the current is switched on than it is when the arc has been burning a short time, and the resistance becomes warm, thus assisting in keeping the current to its normal value, whilst the arc becomes of a proper length.

Resistances for Lowering Lamps.

These are mostly used for stage effects, and if made with switches, should have a large number of contacts to make the graduation imperceptible, or liquid resistances or resistances worked by pressure variation should be used.

Owing to the peculiar nature of the fire risks in the theatre, special care should be taken that the rise of temperature should be small.

In the case of resistances designed by the writer for the Drury Lane Theatre, the specification was that the resistances should not rise more than 80° F. above that of the atmosphere.

Resistances for Meter and Instrument Testing

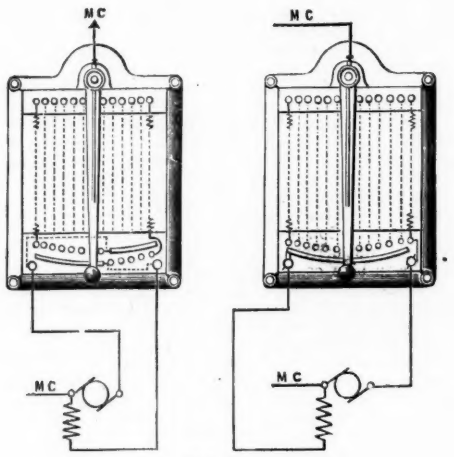
For this purpose resistances with sliding wire, or liquid resistances, have been generally used, enabling the current to be kept at an *exact* value. The "Relugite" pressure resistances is now being adopted for this purpose. It has the additional advantage with alternate currents, that the resistance being inductionless no errors are introduced.

Motor Starting Resistances.

It has frequently been a subject of complaint that the resistances for starting both continuous current and multiphase motors, particularly for small powers, cost almost as much as the motor itself. This has been largely due to want of standard designs specially suited for the purpose.

In general the resistance is not required for more than, say, one minute, but should be capable of carrying the full load of the motor for that time. Some forms recently introduced will only carry the load for 20 seconds; this is not safe.

For the purpose of regulating the speed of motors the resistances must be made larger, and must be capable of carrying a load depending on the range of regulation, but if this is a wide one practically the full load of the motor must be provided for. The simplest way of regulating the speed of a shunt motor is shown in the right-hand diagram, where a resistance is placed in circuit with the armature of the motor, the full line pressure always being on the shunt coil. The left-hand diagram, a modified arrangement, in which part of the speed regulation is effected by varying the strength of the current in the magnet coils. In this case the method of working is to have, in the first instance, the full line pressure on the magnet coils and resistance in the armature circuit. The resistance is gradually taken out of the armature circuit, and resistance is then inserted in the magnet circuit, thus weakening the field and allowing the speed to rise.



M C Main circuit.

Starting resistance with shunt regulation. Starting resistance without shunt regulation.

If this form of regulation is to be adopted, the magnet windings should be specially arranged for the apparatus to have a low resistance, so that the motor is considerably over excited at starting.

In order to avoid the possibility of a motor being switched into circuit rapidly, it is preferable to fit such resistances with a screw motion, but if this is done arrangements must be made by a separate switch or otherwise, so that the circuit can be broken instantaneously in the case of accident or emergency.

An important point in connection with regulating resistances, particularly where the variation in resistance from point to point is considerable, is the question of the switch contacts, as considerable sparking occurs on the contacts, which, from this cause, become dirty or roughened, and causes considerable trouble.

In a form of switch pillar for starting and regulating speed of motors designed by Messrs. Royce, independent quick-break contacts are fitted at each resistance point, and the final break is effected by a carbon contact. In a form designed by Pochin, the switch arm itself carries a small wiper which takes the spark, and it may be renewed as required.

In the case of pressure resistances these precautions are unnecessary, and even in the case of resistances with multiple contacts and filled with "Relugite" material, owing to the fact that such resistances are inductionless, the spark on the contacts is practically eliminated.

Conclusion.

In conclusion, the writer desires to point out the advances which have taken place in the last few years in the design and manufacture of resistances, owing largely to the increased demand, and therefore to the specialisation which this has allowed, and hopes that the notes contained in the foregoing paper will prove of interest to the members of the Northern Society of Electrical Engineers, who have doubtless had considerable experience not only of the merits, but of the disadvantages, to which this class of apparatus is liable.

From a manufacturer's point of view, it is greatly to be desired that engineers designing plants will endeavour to avail themselves of manufacturers' existing patterns and standards rather than to specify for particular arrangements, as it is only in this way that the cost of accessories of the electric light and power plants can be brought to a point which will have the effect of greatly stimulating the use of electrical appliances in many cases where at present the admitted advantages do not outweigh the expenditure necessary.

* Abstract of paper read before Northern Society of Electrical Engineers.

A TABLE OF TELEGRAPH ROUTES TO SPAIN AND TO THE WEST INDIES

SHOWING THE VARIOUS SUBMARINE CABLE COMMUNICATIONS, SOME OF WHICH MAY BE AFFECTED BY THE PRESENT WAR.

	Sections.	Countries.	Proprietors.
Spain	Portbcurno, England, to Vigo	Spain	Eastern Telegraph Company.
	" " Carcavellos	Portugal	" " "
	Falmouth, " Bilbao	Spain	Direct Spanish Telegraph Company.
	Marseille, France, to Barcelona...	"	" " " "
	Emden, Germany, to Vigo	"	Deutsche See Telegraphen Gesellschaft.
West Indies (Cuba, &c.)	Atlantic cables	... ...	Various.
	Halifax-Bermuda	English	Halifax and Bermudas Cable Company.
	Bermuda-Turk's Island	"	" " " "
	Turk's Island-Jamaica	"	" " " "
	Jamaica-Santiago de Cuba	Spanish	West India and Panamá Telegraph Co.
" " "	Atlantic cables	... ...	Various.
	Landlines to Punta Rassa (Florida)	U.S. America	Western Union Telegraph Company.
	Punta Rassa-Island of Key West	" "	" " " "
	*Island of Key West-Cojimar (Habana) ...	Spanish	" " " "
" " "	French Atlantic cables	U.S. America	Cie. Francaise des Câbles Télégraphiques
	New York-Hayti	Republic of Hayti ...	" " "
	Hayti-Guantanamo (Cuba)	Spanish	" " "
South Coast of Cuba and Jamaica.	†Batabanó-Cienfuegos	"	Cuba Submarine Telegraph Company.
	Cienfuegos-Santiago de Cuba	"	" " " "
	Santiago de Cuba-Jamaica	English	West India and Panamá Company.
West Indies (Cuba, &c.), *viâ* Brazil.	Cadiz-Canary Islands	Spanish	Spanish Government.
	Canary Islands-Sénégal	French	Spanish National Submarine Telg. Co.
	Sénégal-Fernando Noronha-Pernambuco ...	Brazil	South American Cable Co.
	Pernambuco-Ceará-Maranham-Pará	"	Western and Brazilian Telegraph Co.
	Or by landlines Pernambuco to Pará	"	Brazilian Government.
	Pará-Cayenne	French Guiana	Compagnie Française des Câbles Télégraphiques.
	Cayenne-Paramaribo	Dutch Guiana	
	Paramaribo-Martinique	French	
	Martinique-St. Thomas	Danish	
	St. Thomas-Puerto Plata	Republic of Santo Domingo	
	Puerto Plata-Cape Haytien-Môle-St. Nicolas ...	Republic of Hayti ...	
	Môle St. Nicolas-Guantanamo (near Santiago de Cuba)	Cuba (Spanish)	
" "	Portbcurno (England) to Lisbon	Portugal	Eastern Telegraph Company.
	Lisbon-Madeira-St. Vincent	"	Brazilian Submarine Telegraph Co.
	St. Vincent-Pernambuco, and from Pernambuco onwards as per preceding route	Brazil	" " " "
West Indies (Cuba, &c.), *viâ* the River Plate.	To the River Plate *viâ* the South American Cable Company, or the Brazilian Submarine Telegraph Company, and the Western and Brazilian Telegraph Company.		
	River Plate-Valparaiso	Chile	Landlines.
	Valparaiso-Lima-Panamá	Perú	Central and South American Telg. Co. / West Coast of America Telg. Co.
	Panamá-Colon (Aspinwall)	Republic of Colombia ...	Landlines.
	Colon-Jamaica	English	West India and Panamá Telegraph Co.
	Jamaica-Santiago de Cuba	Spanish	" " " " "
West Indies (Cuba, &c.) *viâ* the States, Mexico, and Central America.	Atlantic cables	... ...	Various.
	U.S. landlines to Galveston	U.S.	Western Union Telegraph Company.
	Galveston-Tampico-Vera Cruz-Coatzacoalcos ...	Mexico	Mexican Telegraph Company.
	Coatzacoalcos (Gulf of Mexico) to Salina Cruz (Pacific) landlines	"	Central and South American Telg. Co.
	Salina Cruz-San Juan del Sur	Republic of Nicaragua ...	" " " "
	San Juan del Sur-Panamá	Republic of Colombia ...	" " " "
	Panamá-Jamaica-Cuba	... ...	West India and Panama Telegraph Co.

* The cables between Key West and Habana are reported to have been cut by U.S. vessels.
† Both Batabanó and Cienfuegos are connected by landlines with Habana.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

EARTH RETURNS FOR ELECTRIC TRAMWAYS. By H. F. PARSHALL, member. Paper read April 28th, 1898.

Considering the small difference of potential at which electrolytic action may take place, a matter of primary importance in electric tramway systems in which the rails are used as return conductors, is in reference to the rate of fall of potential, and the difference of potential between the rails and the general mass of earth, the magnitude of which may vary according to such local conditions as the locality of gas and water pipes, the conductivity of the earth between the rails and such pipes, and the conductivity of the pipes themselves.

The exposed surface for leakage of the track is very great; thus in the ordinary four-track tramway system there is some 50,000 feet per route mile. With so great a surface, and with, as is generally the case, considerable conductivity of the concrete and earth, a large fraction of the current may be diverted from the rails, even in short lines, and with a maximum drop as small as that specified by the Board of Trade.

Thus, in tests recently carried out in a line some 8 miles long, it was found, by cutting the track at the middle of the line and inserting an amperemeter, that some 60 per cent. of the current was returning through the earth itself. Tests made as to the conductivity of the earth return showed as a whole that it was about one and a half that of the rails, bonds, and fish-plates, which would indicate that on an average about 33 per cent. of the current was leaving the rails. In other words, the voltage drop in the earth return was but two-thirds of what it would have been had the current been wholly in the rails.

In laying the rails, therefore, it seems desirable to adopt such methods of construction as will, to a considerable extent, insulate the rails from the adjacent mass of earth. The conductivity of the earth is considerable, and with differences of potential up to the limit established by the Board of Trade is so great that, in the cases I have examined, stray currents are not diverted from the mass of earth by gas and water pipes. I have made tests by cutting the rails and measuring the currents at different points, and, so far as could be determined, the neighbouring gas and water pipes were not traversed by the current. In one special case two lines of the tramway formed two sides of an acute angle triangle, and a very large water main formed the third side, and even though some 50 per cent. of the current did not come back through the rails, the tests showed

beyond doubt that there was no current whatsoever coming across the third side of the triangle through the water pipe. Of course, with the small difference of potential common in practice in this country, the C.E.M.F. of polarisation which accompanies currents flowing between conductors when electrolysis takes place is an important element in determining the law of current-flow.

The tests carried out by the writer have in every case shown that the joint conductivity of the rail and the earth is considerably greater than that of the rails themselves. For this reason there exists the necessity of determining the conductivity of the rails, fish-plates, and bonds, before the track is laid in the earth, so that after a roadway is completed the measured drop may be taken as an indication of what percentage of current is straying from the rails; further, so that tests made from time to time may indicate the general condition of the bonding.

In general it is desirable that the earth return be isolated to the greatest degree practicable from any other metallic conductors liable to be affected by electrolysis. In some cases, however, where the drop in the earth return has been comparatively great, attempts have been made to prevent electrolysis by bonding the rails to the adjacent gas and water pipes. The results have been more or less satisfactory. It is obvious that, if the rails and adjacent gas and water pipes can be kept at the same potential, electrolytic action can be effectively prevented. Considering, however, the very considerable conductivity of the earth, it would seem doubtful whether such bonding would prove effective with any considerable drop in the rails, since in this case stray currents would flow from one part of the system to another, and at such a difference of potential as would cause electrolysis.

In the case of lead-sheathed cables running parallel to earth returns of tramways, the results have been entirely satisfactory and are conclusive, since, in the absence of bonding, the lead sheathing was rapidly eaten away. This instance, however, is not to be relied upon as an indication that it would be safe to carry out the same process in dealing with gas and water pipes. The lead sheathing is homogeneous, of comparatively high resistance, and with small surface exposed to the earth, whereas the reverse holds true with gas and water pipes as ordinarily laid down. I have no doubt that there are cases in which effective bonding of the rails adjacent to conductors might give entirely satisfactory results, but I should hesitate to make any general recommendation to this effect, since in very many cases a result directly opposite might be obtained.

There is such a difference in soils—first, as to corrosive properties; second, as to electrical conductivity—that a general rule which would prevent electrolysis in every case would be unnecessarily severe, and in many cases prohibitive. It is obvious that, where currents stray generally into the earth so as to enter metallic conductors, the difference of potential should not be allowed to exceed that at which electrolysis begins, + the drop in the earth itself.

In a given system of distribution the controllable features in the earth return are practically limited to the method of jointing the cross section of the rails, and the chemical composition of the rails.

The chemical composition of the rails cannot be altered greatly, since rails low in carbon, but of high electrical conductivity, are found to wear away so rapidly that high carbon rails are a practical necessity.

The cross section of the rail in practice is largely determined from mechanical considerations, and in the best practice rails of from 80 to 100 lbs. per running yard are used.

The method of making the rail joints is practically, then, the only factor controlling the resistance of the rail return that is susceptible to wide variation in practice.

The electric welding of the rail joints has been tried in the United States, but thus far the results have not been such as to encourage the manufacturers to advance the use of the system, or the tramway companies to adopt it.

The joints in electrical tramway work are equally objectionable from either a mechanical or electrical point of view, so that a system of perfectly welded rails would meet with general favour. In practice the effect of temperature in causing expansion and contraction has been noticeable in long lengths of welded rails, but the effects thereof have not been of such a serious nature as might be expected from the range of temperature.

From the reports I have at hand it appears that there were unexpected results of the welding process that made themselves evident in the course of time.

First, the electrical conductivity of the welded section was less than that of a solid rail.

Second, the portions of each rail near the weld were so softened as to wear away unevenly.

Another unexpected result was that, owing to the sudden increase and decrease in temperature, the rail took a very high temper at the weld, so that its power to withstand shock was decreased.

To the writer's mind it is not improbable that these mechanical difficulties could be overcome. Welding apparatus of sufficient capacity, however, is costly, and it is frequently difficult to arrange for the amount of power required; so far, therefore, the process has not been employed in this country.

Another method of somewhat the same nature as the process of welding is that known as the "cast weld," or the "Falk joint." This joint is made by pouring molten metal into a metal mould clamped round the rail joint. The surfaces of the cast metal that come in contact with the mould and with the rail joint are chilled, and are thus prevented from forming a perfect weld. I believe it has been asserted that a weld is effected. It seems, however, extremely doubtful, since without the use of a flux a weld is almost impossible between cold wrought steel and molten iron. The rail expands after the metal is poured around it, and remains expanded until after the cast-iron has set, and finally resumes its former size. This affords a slight clearance for expansion and contraction, and accounts for the mechanical success of the joint, which, if carefully applied, makes when new a perfect mechanical track; although, in the writer's mind, the difference of resilience between the part surrounding the casting and the remaining part of the track may eventually cause uneven wearing away of the rail.

The clearance above spoken of undoubtedly admits a certain amount of moisture, so that by the formation of oxide the resistance of the joint increases in the course of time. From the results of tests which I have at hand, it also appears that the electrical resistance of this joint, even when new, varies considerably; so that, considering the low voltage restrictions in this country, it should be used in connection with an efficient form of bond. Owing to the rigidity of the joint, however, copper bonds will undoubtedly be found more durable in conjunction with it than with a fish-plate form of joint.

Bonds.

The bonds generally used up to this time are of the pressure-contact type, and in making any general statements this is naturally assumed as the basis.

In the discussion of a paper read some time ago before this Institution, the writer pointed out that, according to experience with pressure contacts in central station work, 100 amperes per square inch had been found the limit in best central station practice; and that, considering the trying conditions to which bonds are subjected in the earth, one-half of this value would more likely be satisfactory.

In actual practice I have found it advisable to work to a still lower limit, and in most of the systems which I have designed the current-density at surface of contacts does not exceed 25 amperes per square inch. Experience shows this limit a safe one, and that the contact resistance is negligible as compared with the resistance of the rails.

Considering the complicated phenomena accompanying a junction of copper and iron, in respect to the difference of potential caused by the contact of dissimilar metals, and the effect due to a current passing between dissimilar metals, it seems in the normal case that all E.M.Fs. would balance each other, since in the case of the current keeping uniformly through the rails the E.M.Fs. at the positive ends of a bond are balanced, and in the case of one end of a bond losing its contact the additional resistance would be greatly in excess of the unbalanced contact E.M.F.

The design of copper bond should be largely in reference to the permanency of the contact surface. If there is any working between the surfaces, sooner or later there will be a film of oxide, so that the value of the contact is destroyed. The working of the surfaces may be caused by heating from excessive current density, or by lack of flexibility in the bond. Numerous types have been forthcoming. Many of the bonds brought forward during the last two or three years have been designed with a recognition of the importance of greatly increasing the area of the contact surface, as compared with the cross-section of the body of the bond itself.

It is beyond the scope of this paper to discuss all the different types of bonds that have been brought forward from time to time. Samples of many of the different types are exhibited. The copper bonds that the writer has tested, since they have been more generally used in this country, are either of the "Chicago," "Crown," or "Columbia" type, samples of which are before you.

Flexible bonds are found desirable for use where the mechanical conditions are such that short bonds can be used, in which case the added resistance of the bonds to the track can be made as low as 5 per cent., or less. Bonds of this type have been frequently used in the United States, and with good results when the ends are made of drop forged copper. When, however, the ends have been made of cast copper, and cast on to the conductors, the results are not generally satisfactory. The resistance of cast copper is so much greater than that of drawn copper that it is not best suited for use in bonds. Further, the union between cast copper and drawn copper wires is imperfect, so that the electrical resistance is much higher than between two pieces of pure copper fused together.

The remaining type of bond that I propose to discuss is that known as the "plastic" bond, which was invented by Mr. Edison several years ago. From the results obtained from a line bonded over five years ago, it appears that this plastic alloy, which consists of mercury and other ingredients, as to the nature of which I am uninformed, is much more permanent than might be expected from its mechanical nature. The bond is placed between the fish-plate and the rail, in a cork receptacle, which is compressed to about half its thickness when the fish-plate is drawn up tightly.

The amount of copper required materially to increase the conductivity of well-bonded rails is so great that in ordinary practice auxiliary track feeders are not commercially practicable, unless they be connected in circuit with a source of E.M.F. to compensate for the drop in the feeder, so that this may exceed that in the track return.

I believe Major Cardew was the first to suggest employing E.M.Fs. in feeders to compensate for the drop therein. In the arrangement, however, of the earth return as originally devised by him, it was necessary to use generators of different E.M.Fs. in the generating station. I have used in my work a generator that is separately excited through a coil in series with the trolley feeder, so that the voltage generated by the armature is directly proportional to the current-output, provided the field magnet is not saturated. The armature is in series with an insulated feeder connected with the rail at whatever point it is necessary to take off current. The results in practice are most satisfactory. It has been found that the machine works perfectly automatically, and limits the voltage drop in the earth return to any desired amount by an adjustment of a rheostat in parallel with the field-magnet coil. Fig. 1 gives a diagrammatic representation of the system.

In a system that I have recently designed to carry some 250 cars, I propose to employ several earth generators feeding in from several

points in the system. Pairs of test wires are run back to the station from various points, one of the test wires being connected to the track return, and the other to adjacent earth plates. The earth generators in the station will be adjusted from time to time, according to the difference of potential between the earth plates and the earth return. As far as possible the adjustments will be made so that the two are kept generally over the system at the same voltage.

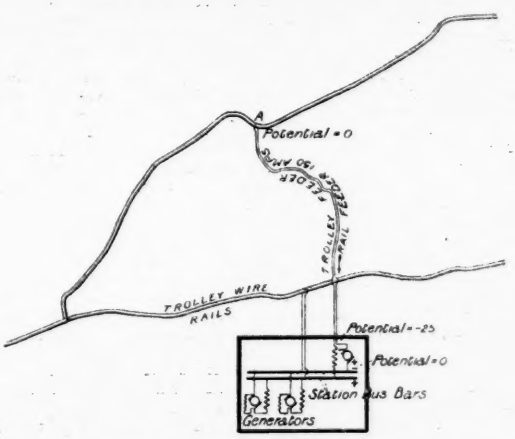


FIG. 1.—RETURN BOOSTER SYSTEM.

Whatever difference of potential there is between the two, will be such that the earth return is, in general, positive to the neighbouring water or other pipes, since in this case whatever electrolysis takes place will be in the track return itself.

STEEL RAILS.

The percentages of carbon, manganese, &c., in steel rails have varied considerably at different times; and there are, even now, wide variations in the practice of different companies, and in different countries.

It may be said that English rails some years back would commonly contain the following:—

Carbon	0·25 to 0·35
Manganese	0·8 „ 1·0
Silicon	0·05
Phosphorus	0·06
Sulphur	0·06

Of late years the percentage of carbon has increased. One large railway company specifies:—

Carbon	0·4 to 0·5
Manganese...	0·95 „ 0·85
Silicon	0·10 „ 0·06
Phosphorus	0·10 „ 0·08
Sulphur	0·08

In American practice the carbon runs still higher, as will be seen from the following:—

Carbon	0·45 to 0·55
Manganese	0·8 „ 1·0
Silicon	0·10 „ 0·15
Phosphorus	0·06
Sulphur	0·06

In France yet higher percentages of carbon have been tried, running up to nearly 1 per cent.

The results are shown in the following table—trials of some sample sections of steel rail of varying compositions which were furnished for testing purposes:—

Carbon.	Manganese.	Silicon.	Phosphorus.	Sulphur.	Resistance compared with copper 20° C.	Resistance of 1 mile 1 sq. in. sectional area at 20° C.
0·378	0 550	0 181	0·040	0 041	10·8	0·468
0 446	0·568	0 188	0 046	0·044	11·1	0 482
0·536	0·592	0 201	0 051	0 059	11 3	0 490
0·568	0·608	0 204	0·053	0 061	11 4	0 495
0 588	0·632	0 214	0 056	0·065	11 5	0·499
0·610	0 650	0·220	0 062	0 071	12 9	0·560

Eight 76-lb. track rails, tested in place after 2½ years' use, gave the following results:—

	Resistance compared with copper 20° C.	Resistance of 1 mile 1 sq. in. sectional area at 20° C.
Test No. 1	11·3	0·490
„ „ 2	10·3	0·447
„ „ 3	10·1	0·438
„ „ 4	10·7	0 464
„ „ 5	9·65	0 419
„ „ 6	10 07	0·437
„ „ 7	10 25	0·445
„ „ 8	10·50	0·455
Average ...	10·4	0·45

Two old 65-lb. rails, much worn, tested in place:—

	Resistance compared with copper 20° C.	Resistance of 1 mile 1 sq. in. sectional area at 20° C.
Test No. 1	11·7	0 508
„ „ 2	12·3	0·534
Average ...	12 0	0 52

High values would be expected owing to the wearing of the rail, which is not allowed for in the calculations.

Two new 90-lb. rails, tested in place:—

	Resistance compared with copper 20° C.	Resistance of 1 mile 1 sq. in. sectional area at 20° C.
Test No. 1	10·6	0·460
„ „ 2	10·4	0·451
Average ...	10·5	0·455
A 66½-lb. rail not laid:—		
	10·0	0·434

BONDS.

The current flows across the joints partly through the fish-plates, and partly through the bonds. The resistance of the fish-plates is a variable quantity, but all tests on rails in use have shown that they contribute considerably to the conductivity of the joint.

For the bonds themselves the following tests have been made:—

(1) Conductivity tests on bond copper.

(2) Resistance due to contacts.

(3) Resistance due to current "gathering" from other sections of rail to enter the bond terminal.

(*To be continued.*)

ELECTRICAL ENERGY (GENERATING STATIONS AND SUPPLY).

(*Continued from page 578.*)

LORD CROSS (chairman) presided over the sitting of the Joint Committee on Thursday, when evidence was given by Mr. James Swinburne, consulting engineer, and Vice-president of the Institution of Electrical Engineers, upon the fourth head of the reference to the Committee, viz., "Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any and what conditions should be imposed—(*a*) with respect to system and plant, and to the construction and location of generating stations in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act of 1888; (*b*) with respect to the relations of the promoters to other undertakers, and to local authorities within parts of the area."

WITNESS, examined by Mr. PEMBER, Q.C., said that it was now being realised by capitalists that electrical energy could be safely and cheaply conveyed a long distance by wires, and there was nothing to prevent the general development of the distribution of power from the pit's mouth, the only thing remaining to check such industrial development being legal difficulties. They could carry extra high electric pressure by comparatively small wires to various places where there was a demand. Overhead wires were used abroad, but in this country only underground wires would be employed. Such systems could supply power at a long distance and over an enormous area. In order to supply such an area there would be local transformer stations or sub-stations, which would be comparatively small affairs, and there would be no smoke, steam, or vibration. Electrical progress was disgracefully behindhand in England, one reason being that it was not realised as it should be, that distribution was as good in the case of coal as in that of water power; the novelty, from the engineering point of view, was practically nothing. He had considered how far an extended distribution was necessary for the purpose of cheapness. He would not say it was a necessity, but it would be an advantage. Besides lighting, there was the question of energy for motors and tramways and light railways. It frequently happened, if there was a central supply, many small villages and towns could be lighted, because the capital cost would only be for distribution. That would be especially advantageous in the Black Country. There was an extreme case to be considered in the fact that looms could be worked by motors. There was no doubt also in the future, that mills and engines, and so on, would be driven by motors. He had lately inspected one of the largest electric factories in Berlin, and found between 6,000 and 8,000 people employed making about 30 dynamos and motors a day. The majority of these motors were for the purpose of driving machinery. For cotton spinning, where uniform speed was an essential, a motor would be preferable to an engine. For all such things as these the central supply would be the cheapest way of bringing the current. With regard to the protection of the consumer, he thought competition might be allowed if the district was served badly either in the way of price or distribution. Local authorities had the chance of competing on exceptional terms with other people. He saw no need for a monopoly being given to any company. All sorts of people scattered about could get power, such as farmers, to drive threshing machinery, and even in an extreme case, it might pay to light up the harvest field all night. A thing managed on a large scale could be worked cheaper than on a small scale. In the case of a town supply, if the local authority worked a station properly there was no reason for the scheme of supplying power in bulk to come in; but if the

station was not worked properly it would be to the advantage of the ratepayers to have a supply in bulk. The only thing which it would be to the advantage of the local authority to purchase would be the low pressure distribution; but even then the conditions were not the same as in the case of an ordinary electric light company. He thought if the local authority had the power to purchase in 42 years they would get a much better bargain than in an ordinary case.

Mr. PEMBER: You think such a distribution would be a great public and commercial benefit?—Yes, and it must be considered from a public and commercial point of view, and not from a parochial point of view.

And you see no reason why there should not be compulsory purchase of land for a generating station as much as in the case of a railway station?—I think there is more reason in this case.

Proceeding, WITNESS said there should be power to break up the roads. It only involved the taking up the roads once to lay down the mains.

Mr. COWARD: The position of the local authorities is this. Should such a scheme as you suggest be authorised without the consent of the local authorities within the area of supply. Is that your view?—I do not see why you should get the consent of, perhaps, 150 local authorities.

Further examined, WITNESS said that he saw no reason why there should be the consent of the local authority in the area where the generating station was erected, because places could be chosen where there could be no nuisance. Some years ago he worked out a scheme of transmitting power from the Midlands to London, and it would pay perfectly. He did not think they could make general principles of purchase fit in with regard to London as could be laid down with respect to the country, because the conditions were so different. He saw no reason why it should not be laid down that the local authorities should fix the route which mains should take, subject to an appeal to the Board of Trade, and also that the local authorities might carry out the work at the expense of the undertakers.

By Lord SPENCER: The chief disturbance to telephones and telegraphs came from electric traction, and no difference could ensue from the supply coming from a distance. He would give the local authority every kind of notice and right to appear before compulsory purchase was adopted.

Questioned by Mr. KIMBER: The cost of coal might be considered the governing power in the supply of electricity. He thought special conditions would have to be imposed with respect to the danger of high voltages, but such conditions could be easily met. It would be fair that notice should be given to the neighbouring owners of the intention to build a generating station. In many of the modern generating stations there was no vibration at all.

Replying to Lord KNUTSFORD, WITNESS said that some protection should be given to the consumer in regard to price, possibly by a reference to the Board of Trade.

By Lord BALCARRES: High pressure and extra high pressure mains were carried overhead abroad. It was a danger, but he thought too much was made of it. It was certainly not the case to say that the carrying of such mains overhead was the cause of considerable loss of life. He would not recommend the carrying of overhead mains in towns.

By Lord MONKSWELL: It would pay to supply London from the Midlands, because of the saving in the cost and handling of coal. He thought the ordinary law of nuisance should apply to electric lighting companies in towns.

Questioned by the CHAIRMAN, WITNESS said if they got the power to erect these large generating stations, they were safe from purchase.

Mr. HENRY GRAHAM HARRIS, partner of Sir Fredk. Bramwell, said his firm had erected several electric stations. They had been consulted with regard to the supply of electricity at high voltage from long distances, and the supply to a large area from a central station would be economical, and would lessen the price to the consumer. There were several grounds of economy. The management expenses would be less, and the cost of the installation of the works per unit would be less. Larger units of machinery were cheaper, proportionately. The cost of collection would also be less. The current could be used for various purposes besides that of lighting. He agreed generally with the evidence of the preceding witness.

Questioned by Mr. COWARD, WITNESS said he agreed with the evidence of the previous witness that the local authority should have the right to direct the route of mains in their streets.

By Mr. KIMBER: He thought the sliding scale of the gas companies was a good thing, but the question was that there should be no purchase if the scale was adopted with electric lighting companies.

By the CHAIRMAN: Before the Electric Lighting Act of 1888 extended the time to 42 years, it was not worth while for capitalists to put their money into such undertakings, because the period was not sufficient and the risk too great. It was extremely doubtful now, in some cases, whether 42 years was sufficient, but in a large number of cases it was sufficient.

Mr. JOHN FRANCIS ALBRIGHT, chairman of the Midland Electric Corporation Scheme, said his view upon giving a power to a company to supply wholesale was, that it was important to a company like he represented to have the power to supply to corporations for lighting purposes. At the present time the company was in a dilemma, because, whereas they contracted with the corporations to supply them only, yet, under the law, they were called upon to supply all demands. He did not say that such corporations as Manchester and Liverpool could not supply as cheaply as a large company, but a small local authority could not do so.

By Mr. KIMBER: He would not object to the sliding scale. He could not say at what price the London companies could supply light, because the conditions were so different.

By Sir ALFRED LYELL: In London there would never be the same demand as in the Black Country.

Mr. PEMBER said that would conclude the case for the companies.

An argument took place with Mr. STEVEN (representing the present companies) as to calling witnesses, and it was decided that he should not.

Mr. CRIPPS (Parliamentary Agent) asked that the Metropolitan Electric Lighting Company should be heard. That company was the largest in London, and as Mr. Pember was representing a combination of competing companies their interests were not identical.

The CHAIRMAN said the Committee would hear counsel for the company on any new point.

The Corporation witnesses were then called.

Mr. HIGGINBOTTOM, Alderman of the city of Manchester and chairman of the Corporation's Electricity Committee, was first called. He said that the Corporation had power to supply energy to the whole of the city, and they were also the undertakers of surrounding communities. The demand had become very great. Manchester had always maintained that the Corporation should have sole and absolute control of the streets. Gas, electric lighting, and hydraulic power were all supplied municipally. The duplication of electric mains would be extremely undesirable. The electric supply in Manchester had been a very profitable undertaking from the first. Local authorities ought to have power to acquire land compulsorily, and companies should be in the same position. Electrical undertakings should be exempt from proceedings for nuisance, where proper care was exercised. As far as possible, all stations should be confined within the area of supply, and in laying mains between an outside generating station and the area of distribution, the local authority should have the right of determining the route of the mains, and of itself doing the work of laying down if it so wished. The consent of the local authority should be necessary to any undertaking for the supply of electrical energy, and the right of purchase given under the general Act should remain. The case of London, he thought, was quite different from that of the other great provincial towns.

Lord Cross presided on Monday over a further sitting of the Joint Committee.

Sir SAMUEL JOHNSON, Town Clerk of the city of Nottingham, which had a population of 230,000, said the Corporation already possessed the gas works, and they supplied gas to an area of 100 square miles outside the city boundary. They also owned the water and the tramways. They started an electrical undertaking four years ago, so as to maintain their authority over the streets. It was not thought that the electric station would pay at first, but it had been a great success. They made a profit both from the gas and water. Last year they made £33,000 odd profit from the gas, most of which was due to the city. They attached great importance to the control of their streets. They agreed that Corporations should have compulsory power to purchase land for generating stations. In other words, they asked to be put on the same footing as other undertakings where power was given to acquire land compulsorily for the public benefit. He was authorised to speak for Lincoln, Rotherham, Chesterfield, Doncaster, and some 12 other cities, and the strong feeling of all those places was that they should keep the control of the streets, and that they should not be given up to dividend-seeking companies. There was no objection to the Board of Trade dispensing with the consent of the local authority, if it were shown that there were no good grounds for refusal to allow the streets to be opened.

By Mr. PEMBER: They supplied their largest consumers with electricity at 2½d. per unit. Ordinary consumers were charged 6d. for the first hour. They had about four miles of subways, through which all pipes were carried. The reason he referred to dividend-paying companies was that their chief object was to pay a dividend, and not the public convenience. According to the practice of the Board of Trade, his Corporation had the monopoly of the supply of electric light. In the case of a central supply company wishing to carry a main through their streets, and not to supply the city, they did not object to their consent being subject to the Board of Trade. They committed no nuisance whatever in respect of their generating station. He thought that notices of an intention to acquire land for an electric generating station should be served on occupiers within a radius of 50 yards.

Examined by Mr. BALFOUR BROWN, WITNESS said applications had been made for their consent to electric companies coming into the city, but having invested the ratepayers' money in an electric light undertaking, they did not see why a company should come in. If the Corporation were not doing their duty they should not be exempt from competition.

By Lord SPENCER: When he said the Corporation should have a veto regarding the breaking up of the streets, he meant that that should be subject to the Board of Trade or Parliament. The Corporation had not at present contemplated supplying electric light outside their area. They could generate all the power they required in their own area, but in the case of an authority being unable to generate within its own area, there should be power to carry a main through other areas, subject to conditions.

Questioned by Mr. KIMBER: Their powers with regard to electric light were conferred by a provisional order. It seemed a fair proposition that they should have compulsory powers for the acquisition of land for generating stations. At present they did not supply power; not because they could not do so as cheaply as steam, but simply because there was no demand for it before. Now they intended applying electrical power to the tramways, and the matter was now before the Corporation. They would be able to supply electrical power cheaper than the light, because there would be a day load.

Lord BALCARRES: If a great demand arises for energy in your city, are you convinced that the municipality will be able to meet that demand?—Certainly; to the uppermost.

Your municipality desires a monopoly?—Yes, the same as for gas.

By Mr. ASHTON: The municipality did not appear to have protection in the outside area they supplied with water in respect of interference by electricity. He had heard that 10,000 to 20,000 volts was contemplated being passed through mains, and in that case, in a county like theirs, liable to be broken up by mining operations, the water pipes might be damaged, and the supply to the town stopped.

By Lord MONKSWELL: The objection that manufacturers would not take power from the Corporation because of business secrets leaking out he did not think would hold good, because at present they supplied gas power to manufacturers.

By Mr. KIMBER: His Corporation was opposing the Bill of the General Power Distributing Company.

Further examined by Mr. PEMBER, WITNESS said that after paying off all preliminary charges, and providing for all costs, and all charges such as rates and taxes, interest on money and sinking fund, they made a profit in the first year of £500, and in the next year a profit of £2,200. Then they reduced the price of the light to the extent of £2,000, but still made a profit of £3,600. They were seeking to double their station now, and if they did that, and the demand for light still continued, they would be able to reduce the cost. They had 35,000 8-candle-power lamps, and supplied 4,800,000 units.

Mr. GEO. FRANKLIN, Lord Mayor of Sheffield, said that the Corporation had agreed to purchase the undertaking of the Sheffield Electric Light and Power Company, and they were promoting a Bill in Parliament to affirm the agreement for the purchase. They were opposing the Bill of the General Power Distributing Company. The generating station in Sheffield was situated almost in the centre of the town, and had been running about 12 years with absolutely no complaint as to nuisance. They got a plentiful and cheap supply of coal, and so far as Sheffield was concerned, there would be no advantage in having a huge generating station at the pit's mouth. He agreed as to compulsory powers being given for the acquisition of sites, and they deprecated any interference with the streets. He agreed generally with the evidence of the previous witness.

By Mr. RICKARDS: He thought that municipal corporations could undoubtedly carry out industrial undertakings as economically as private companies. Sheffield was indebted to private enterprise for the starting of an electric undertaking.

Questioned by Mr. KIMBER, WITNESS said that the present Sheffield Company did not supply power, but the Corporation intended to do so, and were making arrangements to work the tramways by electricity. He did not think electricity would be more economical to manufacturers in Sheffield of armour plate and things of that sort. The maximum charge of the Sheffield Company was 4d. per unit, and last year they supplied three-quarters of a million units. With the increase of output and the equalisation of the load, the Corporation hoped to decrease the price considerably. They hoped to bring down the cost in two years to 1d. per unit.

By Lord KNUTSFORD: So far as the mere breaking up of the streets was concerned, they would not object if the work was left in the hands of the Corporation.

Examined by Lord BALCARRES: Two years ago the Corporation would have objected to competition, because when the company went to Parliament an agreement was arrived at with the Corporation.

By Mr. ASHTON: A newspaper notice should be sufficient for neighbouring occupiers of intention to take land for a generating station.

Dr. JOHN HOPKINSON, F.R.S., and past-president of the Institution of Electrical Engineers, said he agreed that both companies and local authorities should have compulsory powers to acquire land for generating stations. With respect to breaking up the streets, the local authority should have the power of withholding their consent, subject to the action of the Board of Trade. The reason that the charge for power could be less than light was that those using power used it for a longer period.

By Mr. KIMBER: He came before the Committee at the instance of the Corporations. He was frequently consulted by electric light companies, and was connected with the Metropolitan Electric Light Company.

Questioned by Sir LEONARD LYELL, WITNESS said there was undoubted risk to gas and water pipes by the working of electrical tramways, but the Board of Trade had laid down conditions which would prevent that, and a careful engineer would take even greater precaution.

By Mr. ASHTON: There were dangers in a town from overhead electric wires, but much greater freedom might be permitted in the country with regard to overhead wires.

Lord BALCARRES: Do you think these great general distributing stations have in them the elements of success?—When their power is very cheap I think they have. In the case of coal I do not think it makes much difference, as coal can be easily carried.

The CHAIRMAN: Supposing you were an autocrat, and had to supply a large industrial area with the cheapest power, would you advocate one central station in one particular place, or a number of them?—A great many. Of course, you must take the particulars of towns into consideration. In the case of London there would be a difficulty of getting a site.

If you had to make a fresh start with London, what would you do?—If I had to make a start with all the experience we have had, I should put the stations outside.

Would you put up one station for the whole of London?—No; probably two or three.

On the ground of economy, how many stations would you have?—I do not think there would be much economy in having only one station, except as regards rent.

But suppose you get the land cheap for the supply of London, how many stations would you have?—Five or six.

Sir ALEXANDER BINNIE, chief engineer to the London County Council, said that at the present time there were in London 26 bodies authorised to supply electrical energy, 14 of which were companies, and 12 local authorities. Of the local authorities with electric lighting orders, five were supplying the areas shown. In consequence of the crowded condition of the streets, the matter was becoming serious, and would have to be dealt with in a more thorough manner than it had been.

Mr. J. W. BENN, chairman of the Highways Committee of the London County Council, described the powers which that body had over the companies in regard to opening the streets. The companies had to ask the consent of the County Council.

By Mr. BALFOUR BROWNE: He quite understood that the Board of Trade was the final authority as to opening the streets. The County Council had no power to purchase any portion of the electrical plant in London.

Questioned by Earl SPENCER: It was quite peculiar to London that the London County Council, while having certain powers over the Electric Light Company, had no power of purchase. He thought they certainly should have power of purchase. In the event of such power being given, they would ask for the power to erect stations outside their own area, and they had a precedent for that in the case of the sewage system.

By Mr. KIMBER: With respect to the proposals to supply energy in bulk, it seemed to him that the power of purchase was valueless to the local authorities.

By Lord CROSS: The County Council would reduce the price of the light before relieving the rates if they owned the electric lighting companies. Municipal ownership was, however, their chief object.

The CHAIRMAN: I thought so.

Earl RUSSELL, late chairman of the Highways Committee of the London County Council, said that if a central supply system was to come in, the power of purchase would have to be in the hands of the central authority.

By Lord BALCARRES: There was no suggestion that the local authorities should be deprived of the right they had now to buy up electric light stations after a certain number of years.

Mr. W. H. PREECE, chief electrician of the Post Office, said that generating stations were required for other purposes than those which had been brought before the Committee. They had been told of the supply of energy for lighting and power purposes which were growing at a considerable rate; but besides that there was the working of tramways, the supply of current for charging batteries for cabs and vans in London, and also generally for traction purposes. Then again, there was a very important field about to be opened, which was the working of existing railways by electricity. The Metropolitan District Railway had obtained a Bill, which had passed through one House, to enable them to work their railway by electricity. In the future, also, electrical energy would be used largely for chemical manufacture and the production of heat. These were things which showed that the construction of these central stations required legislation conditions. Their attention was first called to the nuisance likely to arise by the interference with telephones. Now the Telephone Company had learned wisdom, and the practice was invariably to make the telephone circuit a metallic circuit. With telegraphs it was quite a different matter, for with the enormous system it was impossible to duplicate the wires. Disturbances had been caused at Greenwich Observatory by the City and South London Railway, and at Liverpool by the Overhead Railway. All those disturbances could, however, be remedied. There was one difficulty which up to the present had not been entirely removed, and that was in the working of tramways by the trolley wire system. From them loose currents ran about which affected water pipes and gas pipes. There was no doubt, however, that with stringent clauses appointing proper control these disturbances would ultimately be removed also.

Do the power houses cause nuisance?—They might, but they are remedial. There is, of course, the cartage of the coals and the removal of the ashes, which cannot be avoided.

But vibration with these new engines can be avoided altogether?—Yes.

So that, practically, there is no nuisance?—The only nuisance is possible vibration from neglect.

The operation of opening streets might become a nuisance?—Yes, I would keep that under the local authority.

If you had to start afresh with London, how many stations would you have?—I think London could be served for all purposes if we had four large central stations. Two or three on the banks of the Thames, or two or three on the main railways. That would remedy almost all the difficulties I have enumerated.

Continuing, WITNESS said that the Manchester Corporation had its own station, and they were going to build another large station on the outskirts of their area. Glasgow was a very similar case. Glasgow was one of those places where electrical enterprise had advanced at a very rapid rate indeed. He had visited the great generating station at Niagara before it was opened, and was acquainted with its progress. There they utilised the water-power with the intention of distributing it to places at a great distance; but as a matter of fact, a large town had grown up close to the station. In Buffalo city, 20 or 30 miles distant, they found they could generate the energy as cheaply with coal. He did not think the Niagara station could supply further than 30 miles at as cheap a rate. He thought there should be power to compulsorily purchase land for generating stations.

The CHAIRMAN: Do you look forward to a great increase in the use of electricity in the next few years?—Yes, and I think the progress made in this country has been too much discredited. The progress made in England is very great indeed. Progress with regard to electric tramways has been slow, and that is due to the clauses in the Tramways Act. With regard to electric lighting, I am not sure that we are not in advance of America.

Proceeding, WITNESS referred to the network of pipes of all sorts under many of the streets of London, and he thought the time would

come when the Post Office would have to put itself officially in communication with the London County Council and the local authorities to see if they could come to some terms by which subways could be constructed for the mains.

Sir Courtenay Boyle, recalled, put in a letter received from Mr. Alexander Siemens with regard to the question of insulation in Germany.

Questioned by Mr. Kimber as to the possibility of having a sliding scale for electric lighting companies as in the case of gas companies, Witness said the difficulty was to fix the initial price; but the Board of Trade hoped soon to introduce the sliding scale.

(To be continued.)

HIGH RESISTANCE INSULATION.*

By REGINALD A. FESSENDEN.

(Concluded from page 598.)

As mentioned, this author considered a simple case of Maxwell's general theory, and proved the above results by making actual measurements on condensers and resistances connected up so as to correspond to a simple case of a dielectric of high resistance with conducting particles in it. This paper should be read by all electricians, especially those concerned with cable work. I would like to speak of this subject more in detail, but for lack of time will only add that most of the conclusions in that paper have been confirmed by me, and that some which had been arrived at independently were seen to be in perfect agreement.

It is this absorption and the consequent losses which make glass useless as an insulator against high A.C. voltages. In some experiments made by Messrs. Stanley & Chesney which were shown me, the glass plates of the condenser, when on an A.C. voltage (though thick enough to have stood 10 times the D.C. voltage), after a few moments got hot, sparks could be seen passing inside the glass, and the plates finally broke down. Glass is not homogeneous, as it is made up of a number of substances, some much better conductors than others, and of different capacities, and all stirred together but not dissolved. This is shown by the care which has to be used in getting glass homogenous enough for optical purposes, it even having, as has been told me by Mr. Brashear, to be kept perfectly horizontal when annealing, as the heavier parts tend so much to sink down to the bottom, even when the glass is only plastic, that the only way to do is to keep the levels of different density parallel to the surface of the disc so that their effect on the light will be as equal as possible for all rays. Otherwise one side of the lens would be of heavy glass and the other light, while at present it is so arranged that one face is dense and the other light. Mica is much less objectionable, especially if its cracks are filled up and it is well dried. Paraffin when properly treated makes very good condensers. The old method of piling together pieces of paraffin paper and tinfoil and then pressing them, left much air and moisture inside. This produced large electrical absorption and gave large capacity. Messrs. Hutin & Le Blanc were the first to discover that good condensers could be made by heating such condensers till the moisture and air were expelled. Their results† showed that the specific inductive capacity of this more homogenous dielectric could be reduced from 8 to 2·5. I have myself found it come down as low as two. They then found that the same results could be obtained by heating the paper before making up the condenser. Since then, this method of forming condensers by heating them to expel moisture, air and acid has been used quite generally, with some modifications and improvements resulting in a shortening of the process.

It may be said as a general rule that the capacity of all substances showing absorption may be reduced by this treatment, if the heating be kept up long enough. A great many oils, for instance, are given high capacities, but I have found that in many cases this can be greatly reduced by this method, and that the slight remaining excess of K. over that called for by Maxwell's theory can be almost entirely removed by removing the free fatty acids, mucins, &c. Oils tested by me were olive, castor, linseed, and cottonseed. All these have very high insulation resistance and low specific capacity when so treated and purified, but they soon lose this again when exposed to air. It is evident, therefore, that the anomalous results obtained by Hopkinson and others were due, in some cases at least, to impure material, and such results must be considered as forming a strong proof of the correctness of Maxwell's theory.*

But when the substances are not themselves solid, but viscous, they must have a mechanical backing. For this pure cellulose is generally used. Pure cellulose contains some loosely combined moisture. Consequently it can exist in two states. Dried below 100° C. it decreases its specific inductive capacity very much, and has very high resistance and is flexible. Kept above 100° C. for any length of time it loses some of its combined water, has a much higher ohmic resistance, and its specific inductive capacity sinks to 1·9 or 2. It, however, becomes very brittle, and even though the temperature be only a few degrees above 100° C., it finally cannot be bent without breaking. (This brittleness must be carefully distinguished from the so-called rottenness which cotton fabrics get when dipped in linseed oil and dried. The fact that cotton tears easily in such a condition is due to the same cause as makes a wire mosquito netting tear when painted, *i.e.*, the fibres are stuck fast by the varnish and cannot help one another. This can be proven by removing the dried oil, when the fibre will be found to have nearly its original strength.) In this condition it is best suited for making condensers. The paraffin itself is greatly improved, as was pointed out by Hutin and Le Blanc, by heating to about 140° C. Three hours heating I have found satisfactory. The dried paper, immediately on removal from the oven, is plunged into the hot paraffin, so as to protect it from absorbing moisture. The condenser is then made up and boiled so as to remove the air, for several hours. This boiling method was described in a recent patent as a novelty, but it was used by Mr. Chesney at Pittsfield in 1891.

A condenser so made, if perfectly pure cellulose is used (perfectly pure paper is used in practice), and with pure paraffin, will stand 250 volts per thousandth of an inch when the dielectric is less than ·01 inch, and at a higher rate for greater thicknesses, when the effect of small defects in one sheet of paper is not so serious.

Practically the same remarks apply to the making of induction coils. Here, however, we meet with the great difficulty that the paraffin in cooling is sure to shrink, and will leave hollows inside. The way to get over this is to construct the coil so that when cooling the shrinkage will take place outside, just as if one were making a casting of some metal having great contraction. The coefficient of adhesion also should be less between the walls of the mould and paraffin than between the wire and paraffin; also the outside should never be let harden first, as then, of course, a hollow space is left inside. Another precaution is to expel all gases by heating the paraffin for some time above the temperature at which the coils are to be boiled. The coils should be boiled above 100° C. for some hours to drive off the loosely combined water. This destroys the mechanical strength of the cellulose, but as the whole coil forms a solid mass this is of no great consequence.

Silk should never be used where high insulation is required, as pure cellulose, dry and boiled in paraffin, is so much superior to it that there is no comparison. With pure cellulose, coils with only 1,700 feet of wire per inch of spark stand perfectly, *i.e.*, the spark may be five times longer than the coil. In ordinary use, coils having a spark length 3½ times that of the coil have been run for long periods with no breakdowns.

As regards oil insulation for ordinary induction coils, the writer has not had sufficient practical experience. I believe, however, that very good results are obtained. With regard to the Thomson high frequency coil,† there is no question of the efficacy of oil there, especially with regard to ease of repair. As is well known, however, the oil and coil should always be heated above 110° C. for some time if the best results are to be obtained. A very curious increase of insu-

* Extract from a paper read before the American Institute of Electrical Engineers. From an incomplete advance proof.

† *La Lumiere Elec.*; July 25th, 1891.

* A rule connecting this effect with the sign of the Kerr's electrostatic optical effect has been given by the writer.—*Elec. World*, January 2nd, 1897.

† Popularly known as the Tesla coil, on account of his having brought it into prominence through his use of it in his lectures though it was invented and first described by Elihu Thomson.

lating power for high frequencies in oil has been noted by Elihu Thomson, who has suggested that it might be due to inertia of the molecules of oil. To test this, one of the writer's students, Mr. Bennet, constructed a two-phase high frequency electrostatic field. Though insulators placed in this rotated even when placed within a $\frac{1}{16}$th inch glass flask, the effect was found to be due to air currents, and when these were eliminated no movement was obtained, so that the cause of this effect is still unknown, and it is doubtful if true dielectric hysteresis has ever been observed.

So far as Mr. Chattock's experiments and the experience of the writer go, there is not a great deal of difference between the dielectric strength of different substances. It is probably related to the tensile strength. As mentioned previously, the writer* pointed out that there was strong evidence to show that the tensile strength of a substance was due to the mutual attraction of charges on the atoms, and that the observed values agreed well with the calculated and followed the same law. Some time later, Chattock,† in a very interesting and able paper, showed that, as the results of his experiments, the dielectric broke down when the slope of potential was great enough to pull apart atoms having charges of the same dimensions as the ionic charges. This was shown for gases, fluids, and solids, and forms a very interesting—and, I believe, independent—corroboration of the writer's electrostatic theory of cohesion. Consequently, the nearer the atoms are together, and the greater their rigidity, the greater also their dielectric strength.

Chattock's experiments give for solids and fluids :—

Substance.	Volts per cm. for breaking down.
Glass	919.000
Water	1.050.000
Oil	930.000

which agrees well with the theory.

From the above it will be seen that, if the materials are pure, and ohmic resistance is of not much importance, a compound having its molecules held together tightly will have a good dielectric strength for D.C. voltages.

This paper is already so long that I cannot touch in detail on the question of cables. There are also other papers in existence written by men better equipped for the task. I had intended saying something about what Siemens has called the "absurd craze for high insulation resistance," but the fact is now generally recognised, except by inexperienced engineers, that the best cables are those of medium ohmic resistance. I will only mention two methods which have occurred to me as feasible for certain purposes. One is based on the fact that the dielectric strength of air, as shown by the experiments of J. J. Thomson and Peace, increases very rapidly with the pressure, at 90 lbs. per square inch being equal to that of a good quality of rubber. A similar plan, though not requiring any very large pressure, is due to Mr. Westinghouse, who thought of employing it four or five years ago in Philadelphia. The second occurred to the writer on reading Elihu Thomson's article on the use of liquid air as an insulator. It is this: Since ice at only 12 below freezing has a specific resistance of over 1,000 meghoms, *i.e.*, as good as some brands of insulation, why not make the conductors hollow, lay them in a trench filled with water, pass cold brine through the pipes, use the brine for cooling houses, making ice, &c, and let the frozen water act as the insulator. A rough calculation shows that this is commercially feasible, even neglecting all sources of profit from the furnishing of the brine (*i.e.*, if it were used only for cooling the pipes). After making all allowance for friction of fluid, cost of power, &c., the balance comes at the right end, if the line is always fully loaded.

The question is sometimes raised, whether we can ever hope to have a non-inflammable substance which shall be elastic like India-rubber. The probable cause of the elasticity of rubber is known,‡ and it would seem as if there was no reason why such a substance should not be prepared. All we have to do is to coagulate one substance in the midst of another. In fact, we have at present in tetrametaphosphate of sodium such a substance, elastic as rubber, transparent and tough, and when pure, a good insulator. It would be an admirable material if it were not for the fact that the elasticity is due to water, and when this dries out it becomes brittle.

As regards an organic artificial rubber, I have very little doubt but that it will be made as soon as it is understood by chemists that its properties are due to structural and not chemical causes.

Armature windings.—The present methods of using mica leave little to be desired. The writer might mention, however, one novel method he used in a case where very heavy currents were to be carried. Asbestos and silicate of soda, as is well known, form a good coating, but is, however, poor mechanically. The armature bars were wrapped with asbestos string and then coated with the silicate. This made when dry an extremely firm covering which could only be removed with a hammer. Though at first a bank of 100 lamps could be lit up through the insulation, after a little running it dried out to quite a high figure and the machine did good service, at one time running several hours as I am informed on good authority, under such an overload that the carbon brushes were red hot.

In cases where cloth is to be treated, we have a very different question. There are two ways of using cloth, first, as a backing merely, by coating it on the surface with some substance which is supported by it, as plaster on lathing. Many substances work well in this situation, but the fact that little tubes of cellulose are very apt to stick up through the coating, as was pointed out to me by Mr. F. R. Upton many years ago, and that if moisture gets in at the edge it spreads all over, renders it not the best kind of insulation. Rubber is sometimes applied in this way to cotton tape, but though of very high resistance and insulation at first, it rapidly deteriorates. In general it should be said, that where a permanent result is desired, rubber should never be used unless kept in the dark, and out of contact with air. If these precautions be neglected, the life is very short. The other method is to saturate the whole cloth with some substance which will penetrate every crevice; but when this impregnating substance has solidified, it must continue to fill these crevices and capilliary tubes. For this reason no substance which is dissolved in anything else can be used. If, for instance, we try a varnish dissolved in alcohol, it will be found that the strength of the solution in the capillary tubes is much smaller than outside, for the same reason that sea water filtered through sand becomes fresh.* Consequently on drying these capillary spaces are not filled up and let water in. Therefore, unless we adopt the first method and plaster the insulator on thickly and deep enough so that it does not matter whether the support insulates or not, we must use melted solids or drying oils. Unfortunately but few solids which melt are *elastic*, since this elasticity is obtained by a structure which is destroyed by melting, and those solids which melt into thin liquids and remain *flexible* when solid do not preserve this property except within narrow limits of temperature, as can be easily tested by holding under a cold water tap and striking the specimen sharply. Soft paraffin can be used in some cases if the cellulose be well dried and thoroughly saturated. The asphalts cannot as a rule be used, as they never get sufficiently fluid on melting. There is, however, one notable exception : uintaite or, as it is commercially called, gilsonite. This substance I found many years ago had the peculiar property that, when melted, like paraffin or oil, it will pass into the the pores of cellulose or cloth. Having a very high melting point, nearly 300° if I remember, and mixing perfectly with paraffin in all proportions, it gives mixtures which are admirably adapted for induction coil work as these compounds can be made to have high melting points and to penetrate a coil thoroughly. I also, some years later, in 1891, used this material in combination with linseed oil for transformers, the process at first proposed being boiling in vacuum, but it was found that even without this saturation was complete. I understand that this method is still used, though modified in form, by the company for which I first devised it. Of the drying oils, with the exception of some foreign oils as Chinese wood oil, and an African oil whose name I cannot recollect or ascertain, linseed and the drying nut oils are the best. Linseed oil has the remarkable property of expanding on drying. This enables it to fill up all pores. Its durability is evinced by the good condition of old oil paintings. The varnishes crack and go, but the oil

* *Elec. World*, Aug. 8th and 22nd, 1891.
† *Phil. Mag.*, Dec., 1892.
‡ Molecular Physics, Franklin Inst., September 18th, 1896.

* J. J. Thomson, "App. on Dyn. to Phys. and Chem.," p. 190.

remains. Its insulation is not injured up to very high temperatures at which shellac, rubber, &c., would be worthless. This material was used a great deal by the Edison company in its early days, but it often broke down. The trouble was traced to the lead drier, and after many experiments Mr. Marshall, who had charge of this work, finally settled upon the use of pure raw oil. This gave excellent results, and was long used, but took some time to dry, and the writer finally, after many tests, found that borate of manganese drier got rid of the trouble, while, as is well known, it gives a very quick drying varnish. This was used by the United States Company in Newark on their machines, with the result that in 1890, after use for a year, the former reported only two armatures so treated as returned for repair (they were injured by lightning), and no fields. This material was also used by the Stanley Company for transformers. Another advantage of this borated oil is, that it always retains a slight stickiness, and so gives a good joint when wrapping around wires, &c. Many substances so used are not sticky, and let moisture in through the joints. Where a smooth surface is required, it is readily obtained by dusting on a little talc, a method first suggested, I believe, by Mr. Edison. It can also be given a coat of Japan on the outside. Varnish gums should never be used with linseed oil, as they are brittle, and the dried oil is only just flexible enough. Consequently, when the oil has dried the resultant varnish is always very brittle. A temporary elasticity is given at first by the fact that when the solvent has dried off the oil is still fluid and undried, and as the varnish gum keeps the air from getting at it rapidly, it sometimes remain flexible for a year. Such mixtures also crack when cold.

Sample *c* is a specimen of borated oil saturated cloth, which is now between eight and nine years old. It will be noted that it is still fresh and flexible, and a recent dielectric strength test showed up very high, 7,000 volts if I recollect. The pure raw oil is boiled at about 200° with ½ per cent. of borate of manganese for several hours till it begins to be thick.

Non-inflammable materials can be made, as I have pointed out elsewhere, by taking out the hydrogen atoms of hydrocarbons and substituting chlorine. Even paraffin can be thus treated if kept warm, and first turns to a fluid and then to a solid. At one time it seemed as if this process might be valuable, but the use of enclosed conduits has done away with the greatest source of danger from fire.

I will conclude by describing a couple of devices which I have found useful in preventing insulation from being spoiled. Soldering acid, as commonly used is a solution of chloride of zinc. If this falls on cellulose it turns it to a paste. It never evaporates and always takes up moisture from the air, and will gradually eat its way through quite a thickness of insulation. Whether it is acid or neutral makes no difference so far as its action on the insulation is concerned, though the neutral solution does not corrode the wire. Resin has the disadvantage that it is not a fluid, and is clumsy to handle. I have found that by shaking up powdered resin in very strong ammonia, an ammonia soap is produced which works well in most cases. The ammonia dissolves the copper oxide and evaporates afterwards, leaving the powdered resin which is an insulator.

Apparatus can be protected from overheating by putting in the apparatus a small glass tube filled with carnauba wax. This melts near the danger point, but remains quite hard up till then, so that by imbedding a spring and contact in the wax, when the apparatus gets too warm the wax gives, and the spring expanding causes a short circuit, which blows the fuse.

The largeness of the subject must be my excuse for the fragmentary nature of this paper. After I had begun it I found I had made a mistake; what I should have undertaken was to write a book. I trust, however, that some of the points I have developed may prove of interest.

NEW PATENTS.—1898.

Compiled expressly for this journal by **W. P. Thompson & Co.**, *Electrical Patent Agents*, **322**, *High Holborn, London, W.C., to whom all inquiries should be addressed.*

8,988. "Improvements in electrodes for accumulators." C. Alker and P. Mennessier. Dated April 18th.

9,002. "Improvements in, or connected with, apparatus for the manufacture of potassium chlorate or sodium chlorate by electrolysis." J. Brock and The United Alkali Company, Limited. Dated April 18th.

9,047. "Hanger for trolley wires of electric railways." W. A. McCallum. Dated April 19th. (*Complete.*)

9,070. "Improvements in contact shoes for electric railways." W. M. Brown. Dated April 19th. (*Complete.*)

9,071. "Improvements in, and relating to, telegraph and like cables." J. A. L. Dearlove. Dated April 19th.

9,077. "Improvements in enclosed arc lamps." G. Thomas-Davies. Dated April 19th.

9,091. "An improved connector for electric wires and cables." T. E. Taylor, jun., and J. Collings. Dated April 19th.

9,105. "Improvements in apparatus to be used in connection with the electro-deposition of metals." F. Greenfield. Dated April 20th.

9,122. "Improvements in, and connected with, line selectors for telephones." H. Oppenheimer. Dated April 20th.

9,154. "Improvements in electric lamps." T. S. Hill and Peto and Radford, Limited. Dated April 20th. (*Complete.*)

9,178. "Improvements in electro-motors." J. T. Robson, C. H. Marsden, and H. W. Headland. Dated April 20th.

9,197. "Improvements in, and relating to, telegraphic transmitting apparatus." F. G. Creed Dated April 21st.

9,213. "Improvements in electrical heating and cooking." W. B. Spikins and A. H. Mayes. Dated April 21st.

9,218. "Improvements in secondary batteries." G. E. B. Pritchett, T. W. Pritchett, and A. G. Gold. Dated April 21st.

9,237. "Improvements in holders for high tension incandescent electric lamps." G. E. Heyl-Dia. Dated April 21st.

9,292. "Improvements in electrical igniters to be used with gas or oil engines, or for similar purposes." W. Baines, Jun. Dated April 22nd.

9,299. "Improvements in or relating to overhead trolley wires for electric traction overhead electric cables or other wires." R. Hacking. Dated April 22nd.

9,317. "Improvements in electric igniting devices for cycle lamps." G. M. Bauer and F. Krieger. Dated April 22nd.

9,330. "Improvements in controllers for electric motors." R. Belfield. (The Westinghouse Electric and Manufacturing Company, United States.) Dated April 22nd.

9,339. "Improvements in electrical switching apparatus." H. Edmunds. Dated April 22nd.

9,340. "Improvements in electric safety fuses or cut-outs." Veritys, Ltd., and L. J. Steele. Dated April 22nd.

9,380. "Improvements in and relating to alarm clocks and electrical alarms." H. G. Campbell. Dated April 23rd.

9,394. "A process for electric heating and furnace for realising same." A. Roufaut. Dated April 23rd.

9,425. "Improvements in or relating to electrical cut-outs." J. W. Manley. Dated April 23rd.

9,436. "Improved means for electrically heating second-class electric conductors serving as incandescence bodies for imparting to them the requisite conducting power." M. Debi. Dated April 23rd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

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1897.

19,230. "Improvements in a system for the electrical protection of safes." I. Freed. Dated August 19th, 1897. This relates to a protection system comprising of a closed electric circuit; the safe forming a component part of the circuit. On the interruption of the circuit there is a means for sounding an alarm bell. There is an electro-magnet and its armature forming an integral part of the circuit, but arranged outside the safe. There is also a structure provided with a recess; with lugs fixed in the walls of the recess. There are a series of spring pawls fixed to the safe and adapted to engage in the lugs and lock the safe in the recess. 9 claims.

19,518. "Improvements in electric arc lamps." T. Spencer. Dated August 24th, 1897. This relates to an arc lamp adapted to be operated by an alternating current; and consists of a combination of opposed solid carbon electrodes with an enclosure for their proximal ends. There is a choking coil in electric circuit with the electrodes, and an automatically movable core for the choking coil. The core is connected with one of the electrodes so that a reciprocatory movement of the core may be imparted to the electrode. 1 claim.

18,934. "Improvements in automatic electric alarms." P. V. Vandevelde. Dated August 16th, 1897. This relates to an alarm device for use in ordinary window sashes provided with counter balance weights. Below the usual grooved pulley are placed two spring arms fixed to the casement one above the other. They are insulated from one another and connected with a battery. The top one is longer than the other and comes in contact with the weight when the sash is down. As soon as the sash is raised the weight is lowered and the end of the spring arms are so arranged as to spring together; which completes the circuit and operates the alarm. 2 claims.